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Melting Process Chosen Depends on Requirements

Acid Open Hearth and Converter Both Operated By The Detroit Steel Casting Co.—Axle Housing Presents Problem in Molding

By H E Diller

THAT there is "one best way" for doing everything may be true if there are enough modifying conditions added to the statement. It certainly could not be said that there is one best way for melting steel unless it were under given conditions, with special reference to the class of stock available, the kind of fuel most economical at the place of manufacture, the amount of capital to be invested, the conditions under which the steel is to be poured, the use to which it is to be put, etc. Were this not so, the crucible, the side-blow and the bessemer converter, the acid and the basic open-hearth, and the numerous styles of induction and arc-type electric furnaces, would not all find a place in the steel industry. The fact that all these different kinds of furnaces are in use indicates there are circumstances under which each style has advantages over all of the other styles.

FIG. 1—POURING CONVERTER STEEL INTO SMALL MOLDS WITH A HAND SHANK

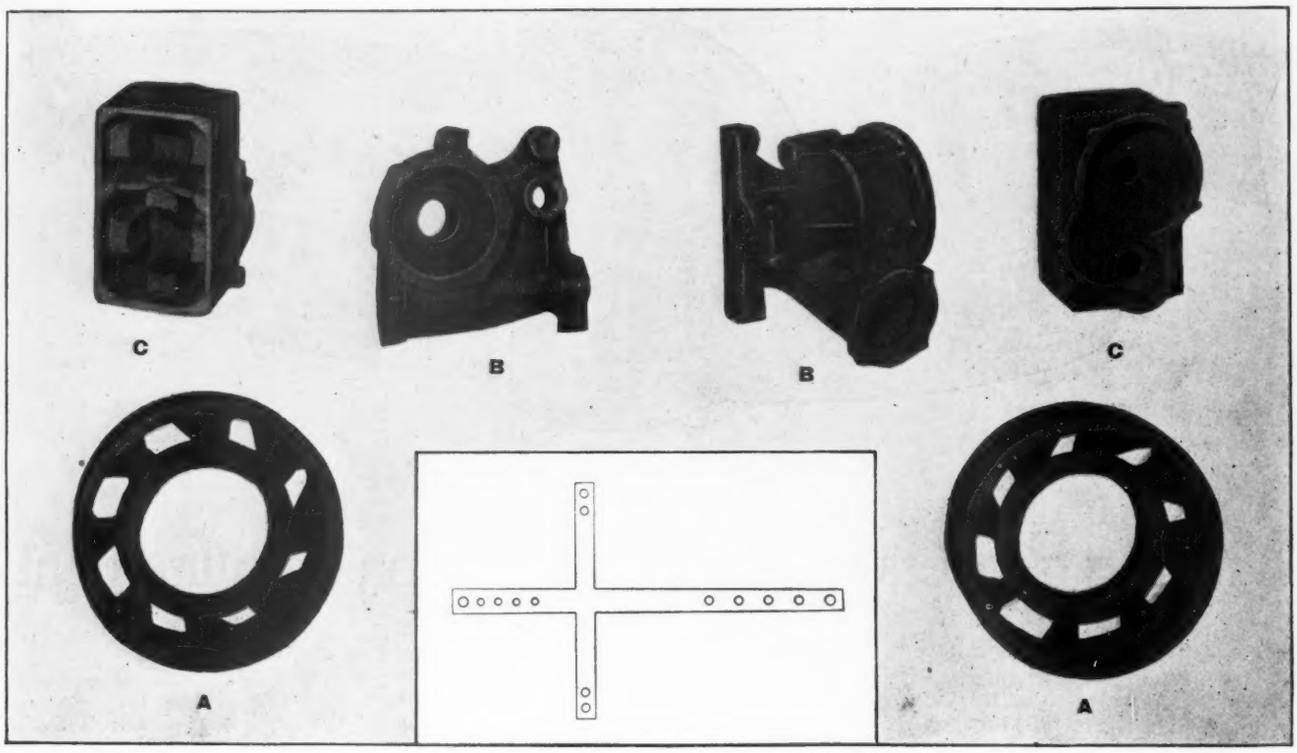


FIG. 2—SEVERAL CASTINGS MADE WITH CONVERTER STEEL FIG. 3—TEMPLET FOR LOCATING DOWEL-PINS IN PATTERNS

So when any one kind of furnace is torn out and replaced by another, or when two different types of furnaces are operated by the same firm, usually some interesting reason for such a situation exists. This is especially true when the steel made by two different kinds of furnaces is all put into castings under the same roof. When a side-blow converter and an acid open-hearth furnace are both operated in the same plant there must be reasons, pro and con, which are worth investigating. By considering some of the conditions and experiences at the works of the Detroit Steel Casting Co., Detroit, some circumstances under which the acid open-hearth is preferable to the converter and vice versa, will be discovered since this firm has two 1-ton side-blow converters and two 20-ton acid open-hearth furnaces. One significant fact is that at present the converter steel in the ladle costs approximately 80 per cent more than the open-hearth steel. This is partly due to the fact that there is a 17 per cent loss of metal in the converter against a 7 per cent loss in the open-hearth. Again the open-hearth charge is composed of 15 per cent pig iron and 85 per cent steel scrap, while in the converter the charge consists of 50 per cent pig iron and 50 per cent scrap. This difference in the amount of pig iron is all the more significant when it is considered that the pig iron used is all low-phosphorus stock which at present is abnormally high. Under more normal conditions the proportionate spread between low-phosphorus pig and scrap would be less.

This question of getting the right stock entered into the production of converter steel to meet government specifications during the war. Prior to the armistice trouble was experienced on account of the sulphur in the pig iron which ran high due to the high-sulphur fuel used in the blast furnace; high sulphur coke also was used to melt the converter charge. At first the specifications for steel castings required not more than 0.05 per cent sulphur. Soon this was raised to 0.06 per cent, then later to 0.07 per cent and toward the last converter steel was being accepted which had 0.08 per cent sulphur. After the armistice the limit was again

FIG. 4—TWENTY-TON CABLE-DRUM CASTING POURED WITH OPEN-HEARTH METAL

brought down until it now is 0.05 per cent as it was originally.

Even with the foregoing disadvantages there are enough compensating advantages to make converter steel desirable for certain classes of work. A great deal hotter metal is obtained by the Detroit Steel Casting Co. from its converters than from the open-hearth furnaces. This enables the transfer of the molten steel from the crane ladle to bull ladles and makes it possible to pour it over the lip into the molds. Being poured this way, in a gentle stream, the metal does not strain the mold as it would were it cast from a bottom-pour ladle. This is an important consideration in the case of small castings with light sections. Fig. 1 shows how this steel is poured from a hand shank.

One-ton heats are made in the converter every 15 or 20 minutes while several hours are required to get a heat out in the open-hearth. The best record made in this respect by the Detroit Steel Casting Co. was when 31 20-ton heats were taken from one furnace in seven consecutive days.

The converter readily lends itself to a certain kind of research in that since the metal is very hot, alloys can be added to a small portion of the heat and different alloy steels thus made. The Detroit company is taking advantage of this fact to do experimental work. One line of research which has given promising results is that of making a heat-resisting alloy with which to cast pots for use in the carbonizing and cyaniding processes.

But the open-hearth is equally well adapted for making alloy steel when the entire heat is to be the same, and a large amount of alloy steel is made by this firm both in the open-hearth and in the converter.

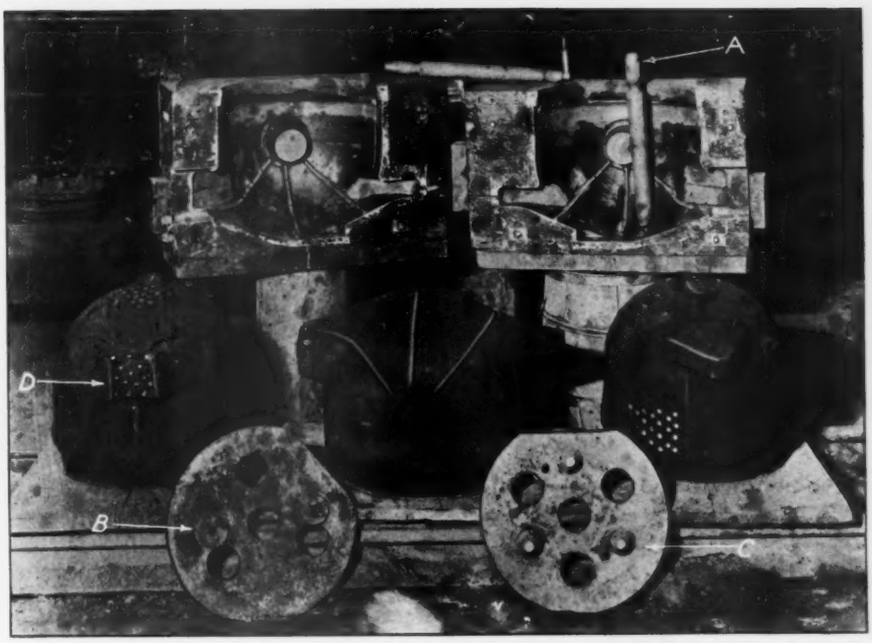


FIG. 6—CORE PLATES, CORE BOX AND FINISHED CORE FOR AXLE-HOUSING

Castings Difficult to Make

Some of the castings which are difficult to make from open-hearth steel but which give little trouble when made from converter steel are shown in Fig. 2. All of the castings shown in this illustration have sections as light as $\frac{1}{8}$ inch. Castings *AA* are brake drums for auto-trucks. The spokes are deflected so that they act as a fan to cool the braking surface. At first more or less trouble was experienced with this casting because it cracked at the intersections of the arms with the rim. This was overcome by using a friable core made of one part rosin and 10 parts molding sand from the Ottawa district, with which a little sawdust was mixed.

Castings *BB* are steering gear cases for Packard trucks. Castings *CC* are housings for electric starters for Ford automobiles. Besides being of thin section these castings make up the poles of the motor and therefore must be made of low-carbon steel. The converter is specially adapted to producing such steel and as low as 0.06 per cent carbon steel is made and successfully poured by the Detroit Steel Casting Co.

The two 20-ton open-hearth furnaces are new; the former furnaces, which were on the ground level, were torn down recently. They have been replaced by the present more modern and economical furnaces, designed and built by Holcroft & Co., Detroit. The new furnaces are raised so that the checkerwork is above ground. This does away with trouble formerly caused by poor drainage. It also makes the slag-pockets more accessible so that they can be cleaned without as much discomfort to the workmen. Previously it was difficult to get the workmen to clean the slag-pockets every week, but since the pockets are now more accessible no complaint against cleaning them is made.

The metal for the charges is loaded in the charging boxes by a magnet suspended on a crane. The same crane lifts the boxes, which are placed on buggies, to the charging floor and the furnace is charged with a machine made by the Wellman-Seaver-Morgan Co., Cleveland. Both furnaces are designed to operate with oil and one can

FIG. 5—AXLE-HOUSING PATTERNS PUT ON METAL PLATES WITH DOWEL-PINS

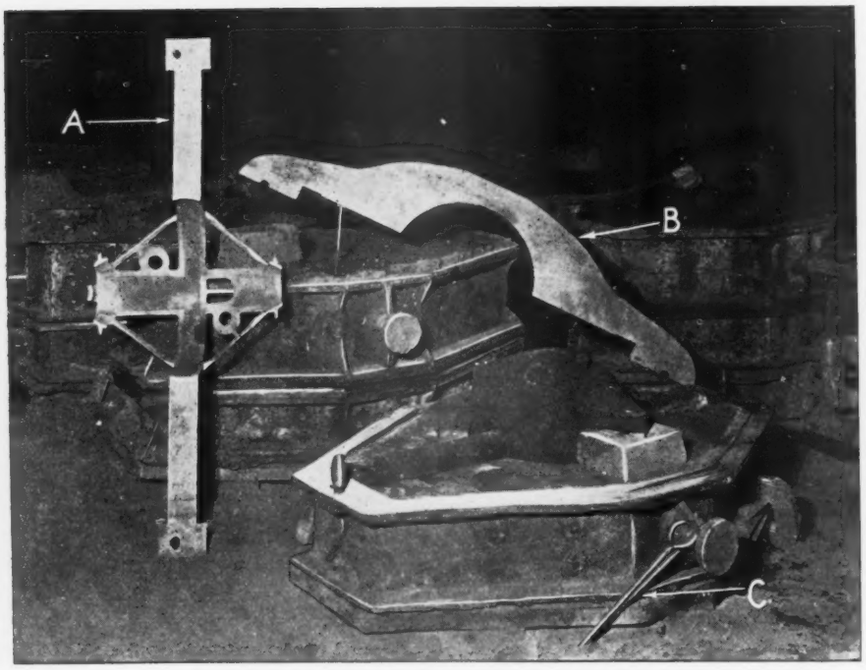


FIG. 7—DRAG PART OF AXLE-HOUSING MOLD WITH CORE SET AND TEMPLETS FOR LOCATING

also be heated with producer gas. A recording pyrometer was installed by the Brown Instrument Co., Philadelphia, with the thermo-couples placed in the checkerwork of each furnace. It has been found that these pyrometers tell whether one end of the furnace is hotter than the other, also how frequently the reversals have been made and indirectly the temperature of the metal. To directly determine the temperature of the metal, an optical pyrometer made by the Leeds & Northrup Co., Philadelphia, is available.

This pyrometer has proved accurate and useful in determining the temperature at different parts of the bath as well as the temperature of the metal as it comes from the furnace. It is also used in connection with annealing to tell the variations in the temperature of the castings in different parts of the furnace.

Leaving the very small castings for the converter, the open-hearth steel is poured into the largest and medium-sized castings. One of the large castings is shown in Fig. 4. This casting is for the cable drum of one of the 350-ton cranes being built by the Emergency Fleet corporation. It weighs 22 tons, but 31 tons of metal were melted to cast it. The 31 tons of steel were all melted in one of the 20-ton furnaces. Steel was taken from only one furnace to avoid a variation in the metal which would have resulted from different furnaces.

While the cable-drum casting is interesting as a melting problem and on account of its size, some of the smaller castings are more interesting from a molding point of view. Among the castings of this class are the motor-truck rear-axle housings which are made from open-hearth steel. For a number of years the Detroit Steel Casting Co. has been making these housings and during this time improvements have been made in the molding methods by E. W. Pike, general superintendent, until now the castings are produced at low molding cost and only a small percentage are lost due to molding or pouring troubles.

The molding problem begins in the pattern shop, therefore careful thought has been given to this end of the work. Three sets of metal pattern-plates have been made and sent to the foundry. In order that these plates need not be returned to the pattern shop each time a new pattern is received, a steel templet, Fig. 3, is used for locating the dowel pins in the pattern. The hole at each end of the long arms corresponds to the dowel pins in the ends of the pattern plates. The other holes are guides for placing the dowel pins on the patterns. One hole at each end and at one side are used for each pattern. In order that a pattern may not be mounted incorrectly after being delivered to the foundry, no two holes have centers the same distance apart as any other two holes. Another precaution taken is that of having 5/8-inch holes at one end and 1/2-inch holes at the other end of the templet, which prevents the reversal of the pattern on the pattern-plate. The two halves of a pattern mounted on plates are shown in Fig. 5.

At first the patterns were split through what are now the upper and lower sides instead of in the way they are now divided. A special flask was made which left the core print extending from the bowl through the side of the flask. This was necessary because when molded in this way it was essential to use a dry-sand core. Such a core would not give sufficiently when the metal solidified. The sections at most places being only 1/4 inch thick, under these conditions, the casting would crack unless the core was dug out as soon as the metal set. This was made possible by having the core-print extend through the side of the flask.

After working with the pattern mounted in this way and experiencing considerable loss from cracked castings, even when taking the precaution of digging out the core as soon as the

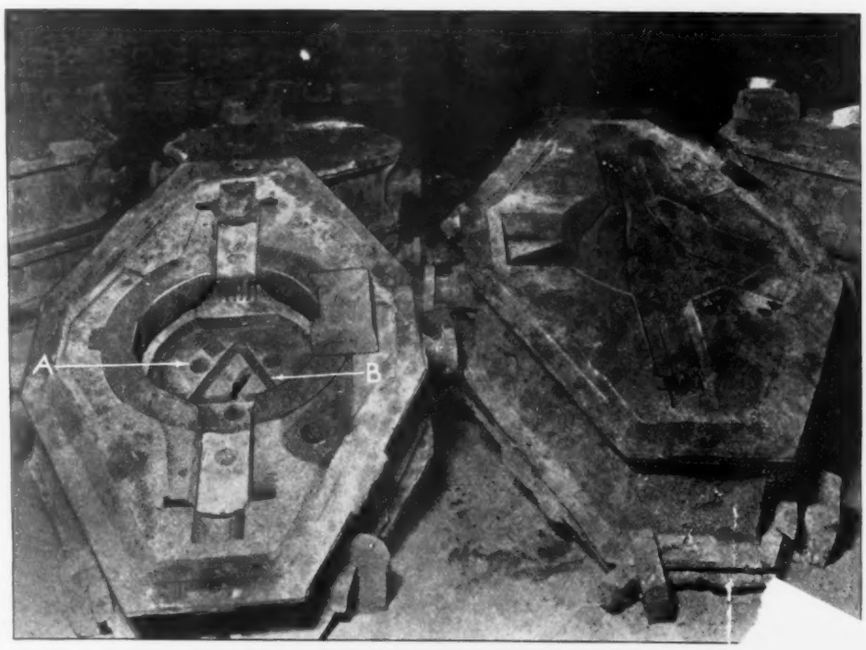


FIG. 8—DRAG AND COPE OF AXLE-HOUSING BEFORE CORE IS SET

metal set, it was decided to split the pattern as shown in Fig. 5.

The new method allowed the use of a green-sand core, which breaks up easily and does not put a strain on the casting causing it to crack. The core box and different views of the core are shown in Fig. 6. One of the things which made this core possible is the core plate shown at the bottom of the same illustration. In making the core two plugs, one of which is shown at *A*, Fig. 6, are placed in the box. The sand is then rammed in, with a center of coke to cause the core to break up readily after the iron is cast. The core plate is shaped so that it will fit into the core box only in the right position. Before it is laid on, the plugs are withdrawn leaving holes in the core above the screw-holes in the plate, *B*, Fig. 6. After the core plate is in position the core box is turned over and the two halves of the box removed, leaving the core sitting on the plate. Before setting the core, eye-bolts, *C*, Fig. 7, are screwed into the core plate and are then used to lift the core. After the core is set the eye-bolts are removed and the holes filled up with dry sand and finished off with tempered facing sand. The three dowels, *C*, Fig. 6, on the bottom of the core plate serve to guide the core and fit into the holes, *A*, Fig. 8, in the drag. Locating the core is not left entirely to this means, but templets, *A* and *B*, Fig. 7, are also used to help place the core correctly. The dowel-pins in the ends of templet *A* fit into the dowel-pin holes in the flask. This templet serves to locate the center of the core, while templet *B* is used to determine whether the cross-arm cores are straight. The cores are thoroughly vented and the gas is carried off through the base of the core. Holes are left in the core plate and grooves, *B*, Fig. 8, are made in the mold to allow the gas to escape. Nails are placed in different parts of the core to prevent scabbing which formerly gave trouble in making these castings. At another place, *D*, Fig. 6, and in the mold, Fig. 8, nails are placed to chill the metal and prevent shrinkage at heavy sections.

It was decided that it would be impracticable to make the molds on a jar-ram molding machine on account of the way the ribs of the casting run, therefore the sand is tamped in with pneumatic rammers. Some of these ribs are indicated in the cope of the mold to the right in Fig. 8. The castings are poured with open-hearth metal from 20-ton bottom-pour ladles.

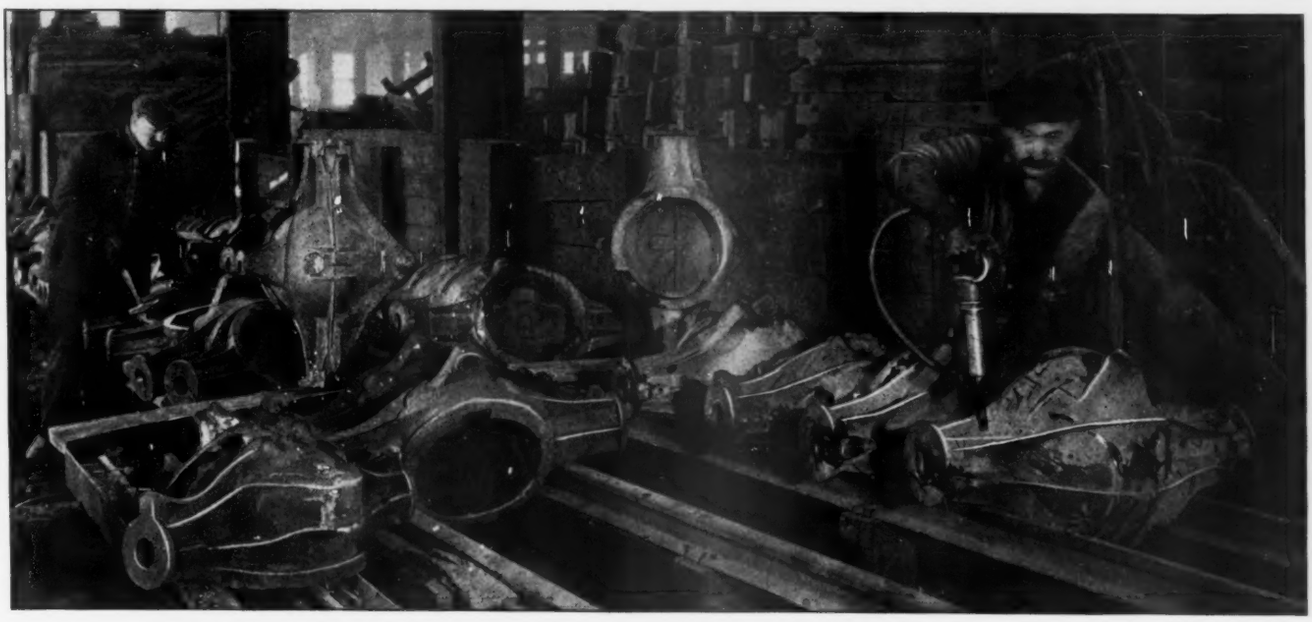


FIG. 9—CHIPPING AND CLEANING AXLE-HOUSING CASTINGS—NOTE HOW CASTINGS ARE SKIDDED ON RAILS

Overcoming Troubles in Malleable

By H. E. Diller

Question.—I would like to know the temperature of the critical point of malleable iron, and at what temperature and how long malleable should be annealed. Also please tell me what causes light malleable castings to break like gray iron, although they can be drilled or filed easily. Our packing gums and sticks to all the castings so tightly that they cannot be taken apart without bending them. How can this be overcome?

Answer.—The critical point of malleable iron will vary somewhat in different irons and is only slightly over 700 degrees Cent., but in actual practice annealing is usually carried on at temperatures higher than this. Castings ordinarily should be annealed in 40 hours after the furnace is up to 880 degrees Cent. A better malleable can be made if the anneal is carried on at a lower temperature, and the length of time can best be determined by actual experience. A definite figure cannot be given as irons of different compositions require different lengths of time for annealing. The time of anneal is also governed by the size of the pots and by the time the coolest portion of the oven lags behind the place where the pyrometer is located and the temperature is taken.

The fact that you have trouble with your light malleable castings not bending, although they can be drilled easily, may be due to several causes. The most probable is that the silicon is too low or that the anneal is not quite sufficient. A complete analysis of your iron would tell definitely the cause of this trouble.

Scale will stick to castings when it is partly reduced or deoxidized. When this occurs the scale can be reoxidized by moistening it with a solution of salammoniac and allowing it to stand a few days, or by allowing it to stand exposed to the weather for a longer length of time. Some foundries overcome the difficulty by packing with sand such as is used for sand blasting. This also saves considerable wear and oxidation of the pots.

Fusion of the scale may also be caused by low fluxing impurities becoming mixed with it and causing it to fuse at a low temperature. To guard against this, use mill scale or hematite ore and see that no impurities become mixed with it. It may also be overcome by sifting the scale, throwing away the fine portions and using only the remainder.

Aluminum Foundry Molding Losses Analyzed

Large Percentage of Defective Castings Due to Causes Which May be Avoided—Chemical and Metallurgical Control Found to be Good

DURING the war the government made a study of the causes of defective castings in three aluminum foundries in order to discover methods of overcoming the difficulties which were encountered in making liberty motor crank cases and other castings. Although the investigation covered aluminum castings only, the findings may also be applied to some extent in other nonferrous foundries and even, in a measure, to iron and steel castings.

For purposes of classification the faults discovered were divided under two headings; under the one, all faults which were considered to be readily avoidable were listed and under the second the faults which were considered difficult to avoid were placed. The faults classed as readily avoidable include shifts, cope drops, hard ramming, wet sand, sand or paste left in vents of cores, run-outs, clamped-off gates washed in, poor patching, molds crushed while cores were being set, cores set wrong, chill drops, cut throughs, cores broken, poured short, cold shuts, sand holes, chill blows, core blows, cores not cleaned, metal poured through riser, core paste loosened, and misruns. It was noted that a larger percentage of misruns occurred at night than at day time.

Among the faults considered difficult to avoid were cracked castings, warped castings, porous and spongy metal, shrinkage, and castings cracked while being welded. While the latter were put in the difficult-to-avoid class it was recognized that the castings were being welded on account of some defect which probably would have been classified as readily avoidable and so should not properly come under the head of faults difficult to avoid.

The first casting studied was a lower crankcase or oil pan. In the first foundry inspected, 1026 castings were made from this pattern. Of these 688 were good and 338 were defective. Among the defective castings there were 268 which were defective due to readily avoidable causes and 70 caused by faults which were difficult to avoid. The 70 were again subdivided, and 46 were classified as faulty through leaks and cracks in the castings as taken from the molds and 24 as cracked while being welded. The foregoing can be summed up as 33 per cent total defectives; 26 per cent defective through faults readily avoidable, and 7 per cent defective through faults difficult to avoid.

Eight hundred molds were cast at the second foundry investigated. There were 380 good castings and 420 defectives. Of 237 defectives caused by readily avoidable faults, 80 were due to chill blows, 28 were crushed, 27 had core blows, 20 sand blows and the remainder were defective through some of the other faults included in the list of readily avoidable faults. There were 183 castings spoiled through faults difficult to avoid as follows: 121 cracked, 34 warped, 20 porous, and eight shrinks. This record shows a total molding loss of 52 per cent, the loss through readily avoidable causes being 30 per cent and that through causes difficult to avoid, 22 per cent.

The high molding loss was partly accounted for by the fact that 15 per cent of the castings were lost from cracks and 10 per cent from chill blows. This was said to be due to the fact that green-sand and dry-sand cores were both used in making the castings, while previously, when dry-sand cores were used almost entirely, the loss from cracks and chill blows was much less. Although normally one would expect fewer cracked castings when using green-sand cores than when using dry-sand cores, it was stated by the foundry management that pouring temperatures should be higher when both green-sand and dry-sand cores are used than where only the dry-sand cores are used. The increased loss of castings from cracks was attributed to this higher temperature. Chill blows, it was stated, would also tend to be less frequent if dry-sand cores are used entirely. Therefore it was decided to revert to the exclusive use of dry-sand cores.

The second casting considered was an upper crankcase. The results on this casting are summed up in the accompanying table. In the case of the third foundry investigated, results are listed were obtained when the superintendent was present and when he was absent. Out of all the castings made in this investigation none were rejected on account of failure of the test bars to meet the requirements of the specifications, nor were any scrapped because of faulty pattern or core-box equipment. The chemical and metallurgical control was found to be satisfactory but much room for improvement was found in the molding practice. As has been shown, most of the defects were from causes which would have been readily avoidable. For this reason it was recommended that thoroughly competent molding inspectors be placed on each shift in every plant making aluminum castings for the government. The advantages which might be derived from this plan were indicated by the large percentage of defective castings resulting from causes which could have been easily avoided and the fact that the third foundry lost 25 per cent of its castings through readily avoidable causes when the superintendent was absent, while under close supervision there was a loss of only 7.5 per cent from the same class of causes. The comparison of the unavoidable causes in these columns is also significant.

Casting Losses From Three Foundries

	First Foundry		Second Foundry		Third foundry Supt. Present		Third foundry Supt. Absent	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Total number of molds cast	701		1000		39		94	
Good castings	555	79	727	73	33	85	63	67
Defective castings	146	21	273	27	6	15	31	33
Defective from readily avoidable causes	85	12	160	16	3	7.5	24	25
Defective from causes not readily avoidable	61	9	113	11	3	7.5	7	8

Reorganize Muskegon Foundry

The Eagle Foundry Co., Muskegon, Mich., has been reorganized with W. E. Jeannot, president; A. Shaw, vice president, and C. Habel, treasurer. Mr. Jeannot is also general manager of the West Michigan Steel Foundry Co. with which company Mr. A. Shaw was also associated until quite recently. The foundry specializes in piston rings and resistance grids, and will employ about 25 molders. S. Shaw, who for many years was with the Allis-Chalmers Mfg. Co. Reliance Works, Milwaukee, and more recently with the foundry department of the American Smelting and Refining Co., Garfield, Utah, has been appointed superintendent.

Making Castings Used in Ship Construction---V

Three Types of Stem Castings Requiring Widely Different Pattern Treatment Are Outlined—Solid and Skeleton Construction are Contrasted

By Ben Shaw and James Edgar

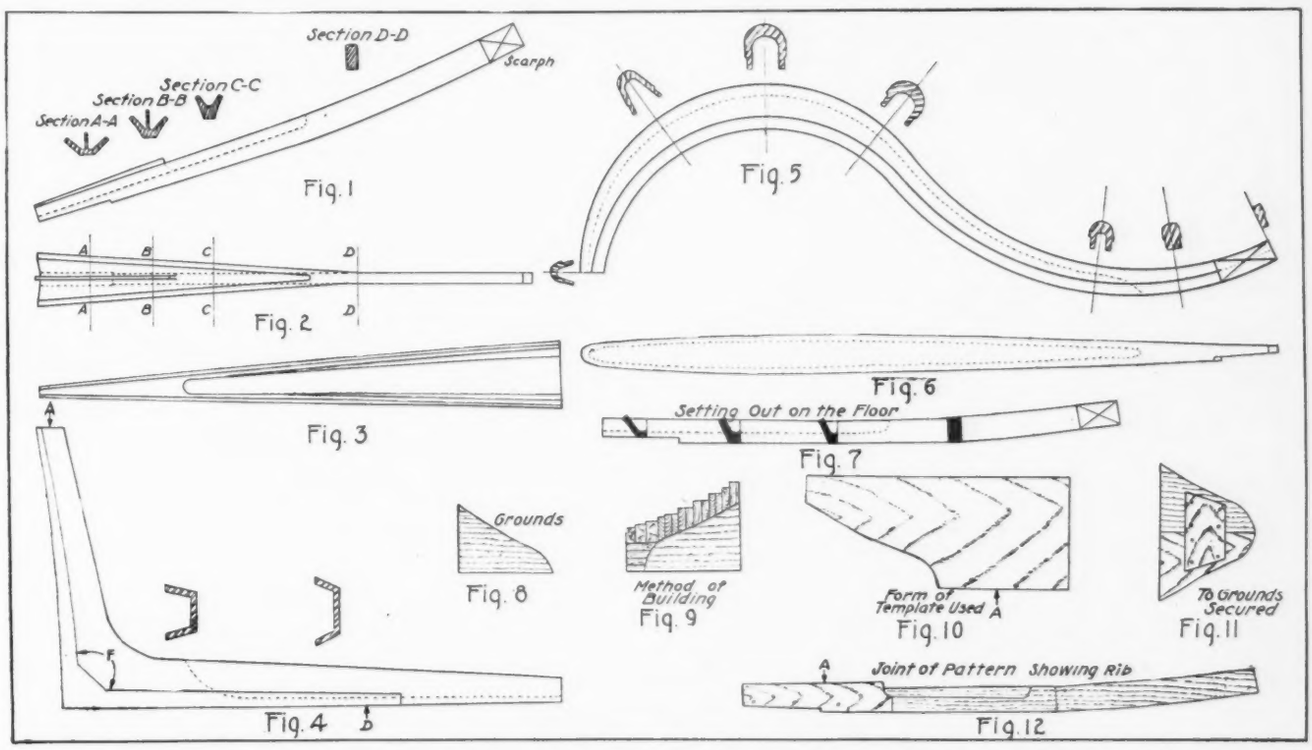
VARIETY governs the design of stem pieces, but the pattern making and the molding is similar in all cases. The cross section is invariably **U** or **V**-shape for the greater part of the length, but sometimes the pieces are simply a straight or approximately straight length. As a general rule the smaller the ship, the simpler the design. Stem pieces can be built on a flat if the center line longitudinally is on the same plane throughout. This usually holds true except in the case of stem pieces for large battleships, when the design is frequently awkward, necessitating an elaborate staking to support the portions of the pattern, which are not on the floor level. As the principles of construction are the same for both types, it will be sufficient to describe the patternmaking of three forms of stem pieces which are commonly used, and which comprise between them any difficulty which the patternmaker or molder may encounter. These three forms are the straight piece shown in Figs. 1 and 2, the right angle piece shown in Figs. 3 and 4, and the ram-nose piece shown in Figs. 5 and 6.

Nearly all steel foundries prefer stem-piece patterns to be exact counterparts of the casting to be made. Their thickness is thus seen, and there is not the same possibility of a mistake as when core boxes are used. In making patterns like this where, apart from the sections given on the drawing, the molder has to use his own judgment in defining the shape, it is not easy to get the corebox absolutely correct in relation to the pattern even with the use of many templates.

When the foundry is given the model of a casting, the molders can make drawbacks or cores, if necessary, to suit conditions. These remarks apply only to this class of large steel work. It would not be possible, even if it were wise, to adopt this practice in engine work. There are foundries, however, which insist on a solid pattern and coreboxes. This quickens the work in the foundry, but increases the lumber and labor bill in the pattern shop. Lightness of construction must be more considered than it has been in the past if patternmaking costs are to be kept within reasonable bounds, and foundries will have to adapt themselves to this condition.

We shall first consider the construction of a shell pattern for the plain type of stem piece Figs. 1 and 2. Laying out the pattern on the floor, Fig. 7, is simple, care being taken to allow for contraction. It is well to paint in half sections at the various sections given on the drawing. Grounds like Fig. 8 about one inch thick will have to be made for these sections, and screwed to the floor, either by means of pocket screws or blocks. These grounds will assist in defining the contour of the pattern after it has been built, and is lifted from the floor.

At first sight it would appear all right to bed a width of sufficiently thick timber on these grounds. If the pattern were small this could be done, but it would not be good practice, as even if dry timber were used it probably would warp. The best way, although the more expensive, is to build



FIGS. 1 AND 2—PLAN AND SECTIONAL VIEWS OF THE STRAIGHT STEM PATTERN FIGS. 3 AND 4—OUTLINE AND SECTIONS OF RIGHT-ANGLE STEM PATTERN FIGS 5 AND 6—PLAN AND SECTION VIEWS OF THE RAM-NOSE STEM PATTERN FIGS. 8, 9, 10, 11, AND 12 DETAILS OF CONSTRUCTION FOR THE STRAIGHT STEM PATTERN

in layers about one inch thick from end to end. Fig. 9 shows a cross section of the built work. It will be noticed that the bottom layers are laid down horizontally and the others vertically. Some may prefer to build them vertically the entire distance down to the joint. As the work tapers in thickness the latter method is easier, but it has the disadvantage of more feather-edge joints.

If the pattern is about 30 feet or more long, it would be a saving of timber to build in two or more lengths, interlacing them. Neither screws nor driving nails should be used, as even with the greatest care points will project and cause endless annoyance when finishing. Further, it is not at all unusual for stem pieces to be altered in design after the pattern is completed. Good joints are essential, and screws may be used temporarily until the glue is set, and then they should be taken out and wooden pegs inserted. When fitting the layers it is essential to chalk or color the grounds, because if a true shape is to be obtained the layers must be well bedded at the various sections.

In some pattern shops, the solid end toward the scarf joints are made from one width of lumber and the building-in layers started only beyond the end of the hollow, but it is difficult to bind the built portion to the other satisfactorily by this method. A better job is obtained by building-in parallel layers from end to end.

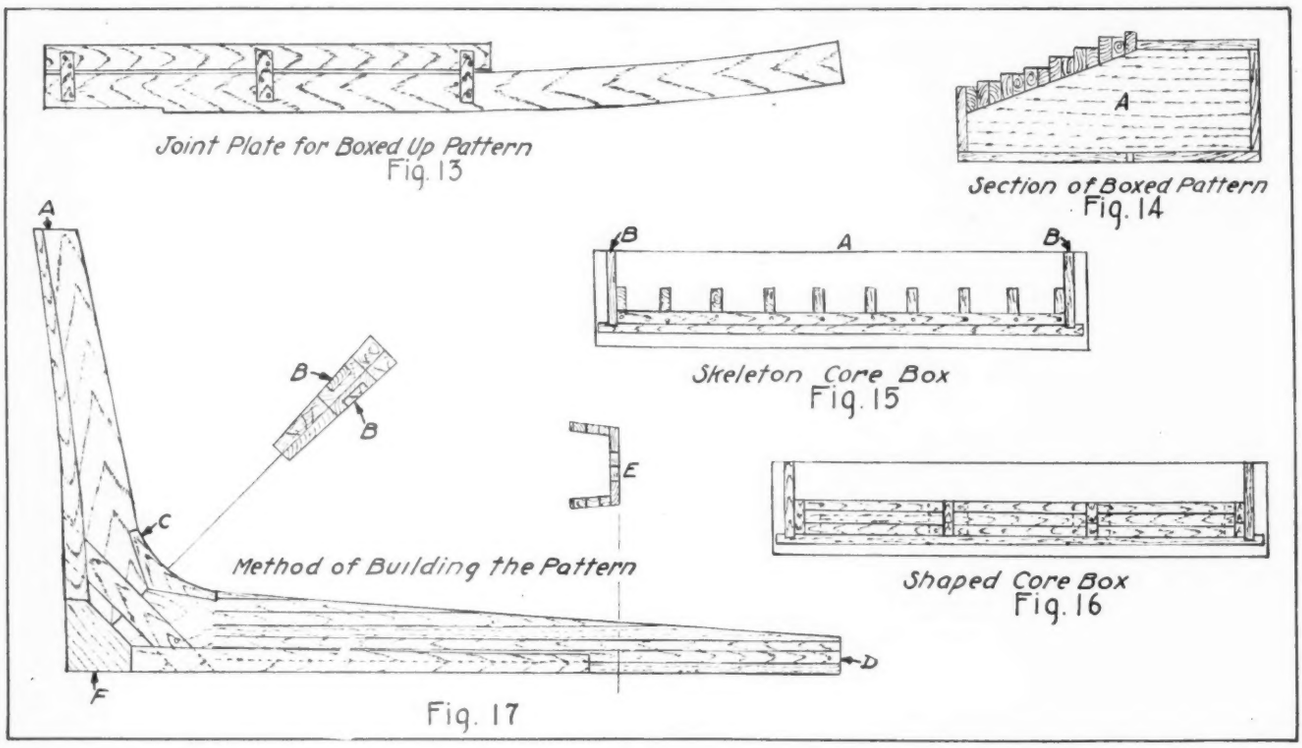
Having completed the building, the inside of the pattern can be left for a time. The outside shape is defined by templates similar to that shown in Fig. 10. The edge *A* rests on the floor while the work is being tested. It is as important to cut the outside sections accurately as it is to bed the layers on the inner grounds accurately. It is not advisable to do more to the outside at this stage than to cut the sections. It is more difficult to finish the inside than the outside. Consequently if the inside is slightly undercut and the outside is unfinished, it is possible to compensate for the discrepancy inside by leaving extra metal outside.

To expedite making the pattern, the two halves sometimes are made concurrently and shaped together, but it is better practice to build one-half on the top of the other. The finished half-pattern should be lifted off the ground and laid inside upon trestles. To support it in a convenient position is a simple matter and building is easier on trestles or on a bench than on the floor. Half-grounds similar to those used when building on the floor should be used for the top, and the batten as shown in Fig. 11 will hold them together. When the top has been built similarly to the bottom, the positions of the given sections should be marked on the outside so that it can be lifted to the level floor, and the template, Fig. 10, used for cutting the shape.

The only difference that may be made between the top and the bottom halves of the pattern is at the solid end. The molder, when making his joint, will follow the top edge of the pattern up to the section *D-D*, Fig. 2, so that it is only necessary to build up to this section. Then glue and screw a single thickness on the remainder of the pattern. The pattern being completely built it is possible to get more men at work finishing off. The inside should be shaped first, gouges and planes being used. A sensitive touch is of greater value in getting a true shape than the use of additional templates. It is wise, however, after the inside is finished to fit several templates, carefully marking the positions. From these templates others can be made for the outside, allowances being made for the necessary thickness of metal.

The rib in the center of the stem piece, shown in Figs. 1 and 2 lies on the joint of the pattern. The method of fastening is shown in Fig. 12. The best way, both for strength and simplicity, is to cut a recess half the thickness of the rib, on the top and bottom halves of the pattern, and screw it down to the bottom. The molder can unscrew it in the mold. If it is wide a couple of hardwood inset battens will prevent warping. This completes the construction of a shell pattern.

If a solid pattern is required for the same type of stem piece, the first task is to make two open jointed plates like Fig. 13. These plates should be made of the thickness shown at *D-D*, Fig. 2, or if this is greater than about 1½ inches an additional thickness can be screwed on for this end, and the hole shaped afterwards. It is not necessary to build in layers beyond *D-D*. A cross



FIGS. 13 AND 14—CONSTRUCTION OF BOXED PATTERN FOR STRAIGHT STEM PIECE FIGS. 15 AND 16—CORE BOX DETAILS FOR STRAIGHT STEM CASTING FIG. 17—CONSTRUCTION OF THE MAIN PATTERN FOR A RIGHT-ANGLE STEM

section of the pattern is shown in Fig. 14. The thickness of print required is largely a matter of opinion. Some foundries are satisfied with a guide of an inch or two, while others insist on a wide print to balance the core. It is a matter for agreement between pattern shop and foundry before the job is started.

The shape of the ground *A*, Fig. 14, usually can be determined from the floor drawing. If the line from *A*-*A* to *D*-*D*, Fig. 2, is concave instead of straight, it may be necessary to make the top plate of the print thicker than the front or back, the concave shape being cut before it finally is fastened. It is not necessary for the portion of the pattern be made of 1¼-inch lumber, and if the bottom is wide it should be open-jointed and battened. The front should be left open, and the width of the back *A* and the ends *B*-*B*, is determined by the print. If the print is concave top and bottom, the bottom of the box may be made straight for the sake of convenience and the convex piece fitted in afterwards.

The ends of the box should be checked into the back. The top strip *C* may be about ¾ inch thick, therefore the shaped grounds will have to be made ¾ inch less than the total depth of the box. A ground should be inserted at each of the given sections. To get the shape of the grounds between these, pattern shop, an inaccurate casting may result. There are two methods which may be employed to fasten the end *A* to the main section. One part may be half-lapped into the other, or a hardwood batten *B*, Fig. 17, may be inset, and the large corner fillet *C* fitted as a separate piece. Half-lapping is to be recommended if the stem is thick, but if it is thin, probably the better way is that shown in the sketch. Joint plates are necessary in making the length *D*, and at the end these become narrow. However, they bind the pattern together.

When these plates are finished the leg can be jointed on. It is best to keep the plates sufficiently thick so that the bevel can be planed off, because it will

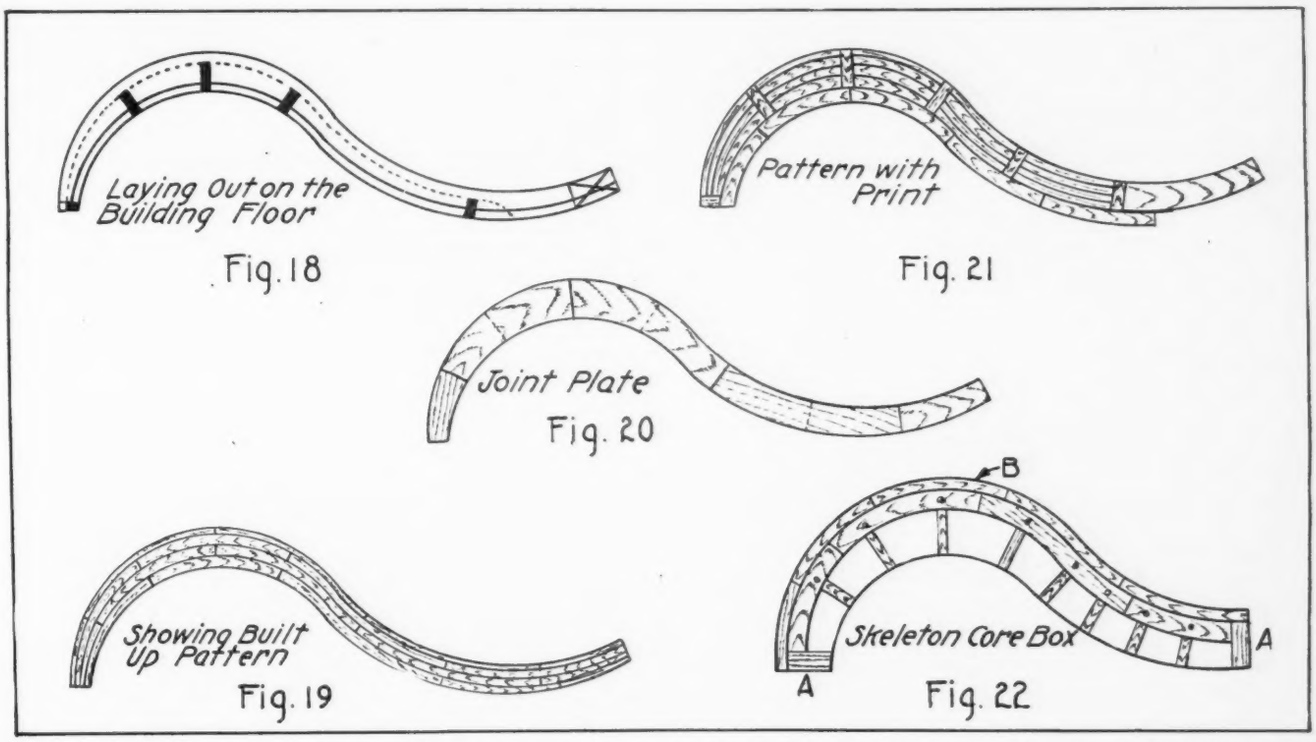


FIG. 18—LAYOUT OF PATTERN FOR A RAM-NOSE STEM FIGS. 19, 20 AND 21—DETAILS OF PATTERN CONSTRUCTION FOR THE RAM-NOSE STEM FIG. 22—SKELETON CORE BOX FOR A RAM-NOSE STEM

which is built of layers to be more than 1 or 1¼ inches thick, if good joints are made.

In making the corebox there is a choice of two methods—skeleton and solid. The labor cost for making the solid box is greater in the pattern shop, but a saving is effected in the foundry. However, lumber is the important item of consideration. Steel foundries nowadays invariably insist on solid patterns, but whether they are justified in demanding solid coreboxes is a debatable question. The ramming of a corebox differs from the ramming of a mold, as steel molds have to be hard rammed. A skeleton box can be filled easily and quickly with ashes and bits of stone or brick. Fig. 15 shows a suitable skeleton box. It is necessary, because of the changing shape to make a full box. The bottom, back and ends can it is best to make templates from the pattern similar to the one illustrated, and make the corebox template from this. The ground should not be more than 3 or 4 inches apart. A solid box is made in a somewhat similar manner. When the given sections have been screwed into position, grounds for supporting staves should be fastened to them. These are shown by the dotted lines in Fig. 16. If possible the faces of these grounds on which the staves will be fitted should be kept on the same plane, as this will simplify jointing the staves. Templates should be used between the grounds at various points to determine the shape. The work of shaping the box is made easier by temporarily removing the ends.

The stem piece shown in Figs. 3 and 4 is difficult to make because of the leg *A*. If care is not taken in the be noticed that the taper from end to end of the stem piece is irregular. The leg should be screwed in place, marked off, and then taken away to be finished. If the leg is wide, battens should be checked into it. The method of building that half of the pattern which is hollow has been described previously. The layers taper into the joint plate at *E*, Fig. 17. Planing the outside of this pattern may be accomplished either by erecting two guides on the floor, or by planing the long length first to the correct angle, and then drawing a line on the end *A* and planing this through. The check piece *F* which forms a recess for the plating is fitted last. It assists also in binding the pattern. When both halves have been made it is well to screw them together and screw on a long diagonal batten just clear of the ends *A* and *B*. The batten is not shown

in the drawing. If a dowel pin is put in at each end, the molder can replace it easily when he draws the pattern. The temporary batten maintains the legs in correct relation to each other. If a solid pattern and corebox are desired, they may be constructed according to the instructions given for making the steam piece shown in Figs. 1 and 2.

The ram-nosed type of stem is not often used. From the patternmaker's point of view it is not more difficult to make than the other forms. Fig. 18 shows the outline drawn on the floor, and the grounds on which the segments are to be built. No rule can be laid down as to the length of the segments. This must be determined by the width of lumber at hand. It is better to have shorter segments and use the full width of timber than to have waste. Unusual care is necessary in shaping a circular pattern of this kind.

A view of the finished pattern is shown at Fig. 19. More labor is entailed if a solid pattern for a ram-nosed stem piece is wanted. Two joint plates, as shown in Fig. 20, first must be made. They should be made by segments about ⅞ or 1 inch thick. When they are cut to shape, grounds about 2 inches thick should be cut for the given sections. The segments can be built between these grounds, which is preferable to the plan of building segments all the way without a proper guide.

It may be thought advisable, after the job is completely built, to fit grounds at each end of the segments to act as supports. This should be done before the shape is finished. Making the print is not difficult. It is best to construct this also of segments, and the shape can be planed afterwards to points taken from Fig. 21. This is a pattern which lends itself to the skeleton method, if the foundry can be persuaded to accept it.

We shall assume that for these jobs the foundry will be satisfied with a good skeleton corebox. When making such a box it is always advisable to enclose the grounds within sides; that is, a box should be made first and then filled. This makes a strong corebox, and it is easier for the molder to fill in than when the ends of the grounds form the sides of the box. To follow this procedure in this case, however, a great quantity of lumber would be used, and in all probability one core would be all that would ever be wanted.

The cheapest effective box is shown in Fig. 22. The bottoms are made of two thicknesses of segments like the joint plate of the pattern. The shape of the core should be accurately drawn on the bottom, and one edge of the plates will form the inside of the box which the molder can strike off with a straight-edge. Strong ends, *A-A*, may be screwed in position, and the grounds, which will have to be made from templates transferred from the pattern, are then cut and screwed firmly to the bottom. The top strip *B* will prevent them from either being broken or knocked over, when the molder is filling the interstices with brick and sand. It is better to complete one-half of the corebox and then build the other on top of it. Dowels may be put into the ends. If the two halves are built separately there are almost certain to be slight discrepancies when they are placed together. This box can be strengthened by a ring of segments screwed to the bottom plate, against which the grounds can be fitted. This is advisable if several cores are wanted.

Pittsburgh Foundrymen Hold Outing and Election

Casting prices, production, labor troubles and all dull care were forgotten for an afternoon and evening on June 16 when the Pittsburgh Foundrymen's association held its annual outing and field day. Over 200 members and guests were taken to a resort near the city early in the afternoon and a ball game between the foundrymen and the supply men followed by races and other athletic events occupied the time until dinner was served at 6:30. President J. Lloyd Uhler, Union Steel Casting Co., presided. The annual election was held immediately after the dinner and the following officers were unanimously chosen for the coming year:

President, Andrew Fulton, Fort Pitt Malleable Iron Co., McKees Rocks, Pa.; vice president, A. J. Hartman, United Engineering & Foundry Co.; treasurer, William J. Brant, William J. Brant Co., and secretary, Bayard Phillips, Phillips & McLaren Co. The directors are J. Lloyd Uhler, Union Steel Castings Co.; J. S. McCormick, J. S. McCormick Co.; Henry Spilker, Sterritt-Thomas Foundry Co.; Clarence E. Williams, Allen S. Davidson & Co., and Carl Koch, Fort Pitt Steel Co.

Following the election, the chairman presented the speaker of the evening, J. T. Holdsworth, Bank of Pittsburgh, formerly dean of the college of economics, University of Pittsburgh. Mr. Holdsworth summarized the business and financial situation and presented facts and statistics to support his statement that the "man is blind, dumb and deaf who doubts" the advent of early prosperity. He sketched the dearth of all manufactured articles abroad, the stagnation which keeps large numbers of men under arms in Europe to prevent flooding the industries with unemployed men. He compared the ratio of national debt to national wealth in this country with that same ratio in other nations. And finally he stated that America can produce most manufactured articles in iron and steel from 10 to 25 per cent cheaper than can even England. All these facts he stated spell prosperity, which however, must be prepared for and met by increased production, industrial peace and sound business judgment. Europe must be helped to shoulder her debt by underwriting a portion of the tremendous burden. Machinery now is being perfected to handle foreign securities marketing them with individuals or holding them in trust and issuing bonds secured by this foreign paper. This will afford credit and enable the nations abroad to buy our products. He made an appeal for broader representation of the employe in every business especially those phases which serve to bring to the employe the sense of his responsibility and share in the problems of production and shop management. The speaker stated that we are on the verge of a labor shortage. He presented an estimate holding that we will lose over five millions of workers by emigration where prior to the war we gained over a million a year. To meet this slack American labor must learn that if it works shorter hours for larger wages it must produce more goods. Intensified methods and greater effort are needed. Following this address Capt. Robert Cain, 111th infantry, 28th division, recounted his experiences in the closing months of the great war.

This meeting concluded one of the most successful years in the history of the association. Meetings have been held every month since last fall with the exception of in October when the influenza epidemic prevented. The next meeting will be held early in September.

Installs New Furnaces

The Steel Alloys Co. of America, Bayway, N. J., recently purchased a Rennerfelt 1000-pound, 400 kilovolt-ampere furnace from Hamilton & Hansell, Inc., New York. This furnace will be used for the reduction of tungsten from tungsten acid. The Hamilton & Hansell company also recently has sold furnaces of the same type to the British American Nickel Co., Ottawa, Can., and to the Dutch government for installation at the experiment station at Batavia, Java, Dutch East Indies.

THE FOUNDRY DATA SHEET, JULY 1, 1919

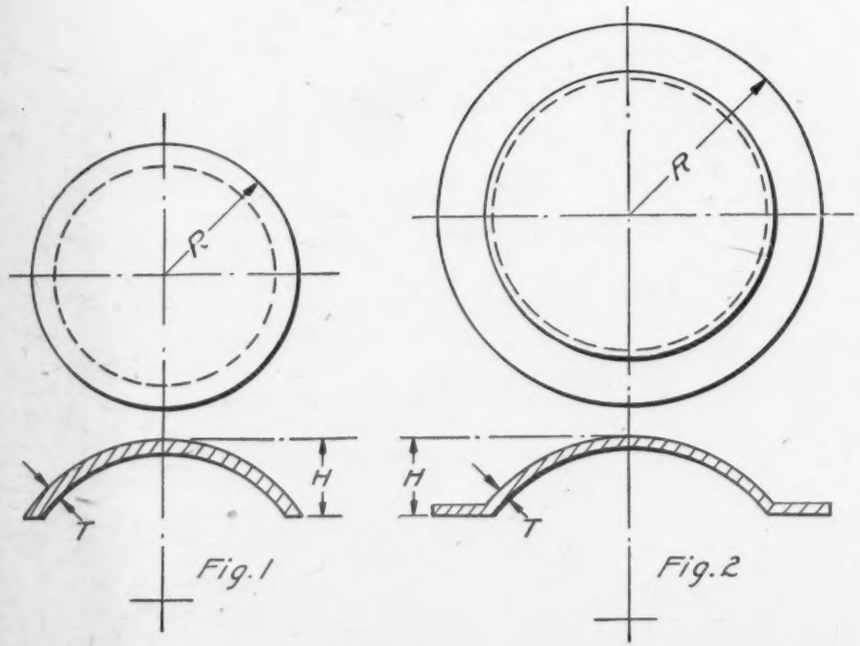
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

COMPUTING WEIGHTS OF CASTINGS

By W. L. Tryon

Caps and Covers



To find the weight of a thin cap or cover, such as shown in Figs. 1 or 2, multiply the sum of the square of the outside radius and the square of the height by the thickness times the constant K obtained from the table below.

$$W = (R^2 + H^2)\ TK$$

Values of K for Various Metals

Cast Iron	Steel	Aluminum	Copper	Zinc	Gun Metal	Yellow Brass
.818	.890	.303	1.00	.793	.990	.950

If R is not greater than 10 inches, the weight can be found by use of data sheets Nos. 177 and 178, as follows:

Add to the weight per inch of a rod whose diameter is $2R$, the weight per inch of a rod whose diameter is $2H$. Then the weight required is this sum multiplied by T.

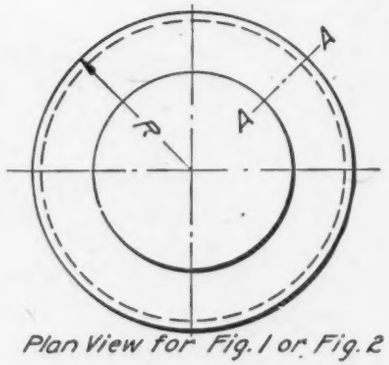
(Concluded on Data Sheet No. 292)

COMPUTING WEIGHTS OF CASTINGS

By W. L. Tryon

Caps and Covers

(Concluded from Data Sheet No. 291)



Plan View for Fig. 1 or Fig. 2

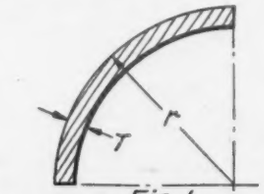


Fig. 1
Enlarged Section A-A

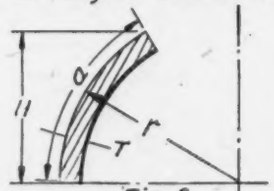


Fig. 2
Enlarged Section A-A

In Fig. 2, A is the length of the arc in inches. All other dimensions are in inches and weights in pounds.

To find the weight of ring made by revolving a thin quadrant of a circle about an axis, as shown in Fig. 1, multiply the difference between the outside radius and one-third of the radius of the quadrant by the radius of the quadrant times the thickness times the constant C obtained from the table below.

$$W = (R - 1/3\ r)\ rTC$$

Values of C and K for Various Metals

Material	C	K
Cast Iron	2.57	1.636
Steel	2.80	1.780
Aluminum	.952	.606
Copper	3.14	2.00
Zinc	2.49	1.586
Gun Metal	3.11	1.980
Yellow Brass	2.98	1.900

To find the weight of a ring with a cross section as shown in Fig. 2, first find the sum of the radius of cross section multiplied by the height and the arc multiplied by the difference between the outside radius and radius of cross section. Then this sum multiplied by the thickness times the constant K is the weight required.

$$S = r\ H + a\ (R - r)$$
$$W = S\ T\ K$$

Making Automobile Cylinders Without Flasks

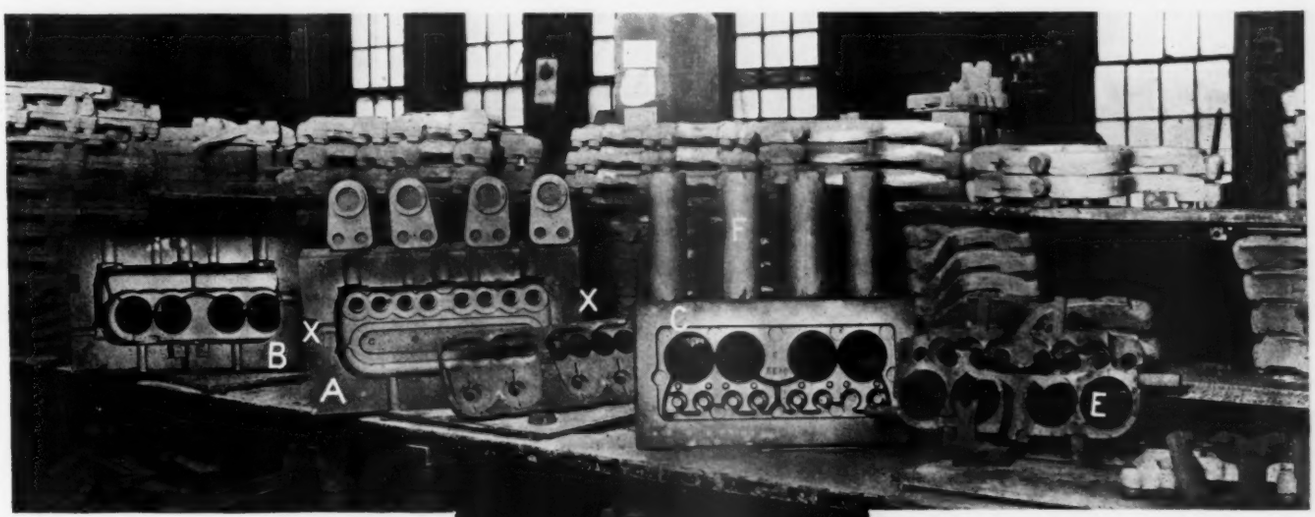
All the Advantages of Dry Sand Molding Are Secured Without the Necessity or Expense of Providing Iron Flasks and Cranes to Handle Them

By Pat Dwyer

THE ancients had a saying to the effect that all roads lead to Rome. The inference, of course, was that Rome formed the center or pivot around which the rest of the world revolved. Perhaps they were right, but, as in other much-quoted sayings, a careful analysis will show that the meaning is more vague than at first appears. Even granting that the statement is true, it is not complete. The ancients should have added a rider or corollary to the effect that some roads offered better facilities for traveling than others; some had lower fares; and some were particularly well adapted for heavy traffic. Therefore a man bound for Rome would consider all these factors and select the route best suited to his time, his pocket book and the amount of luggage he intended to take with him.

It is a far cry from the days of the dusty camel trains on their way toward the city of the Caesars' to this modern year of grace and the manufacture of automobile cylinders. Yet the analogy is there if one cares to look for it. The merchant or manufacturer from the Far East who wished to send his goods to Rome selected the camel as the means of transportation, at least to the nearest seaport. If he chanced to have his place of business in any part of central Europe he had to use pack trains of mules or horses or clumsy wood-wheeled wagons. The object in each case was to get to Rome, but to get there under the most favorable circumstances and with the least delay.

Now consider automobile castings. They can be molded in green sand, dry sand or cores. But what is the use of making them one way if they cost more to produce than they bring in revenue? What is the use of rigging up for ten a day if the demand is for one hundred; and on the other hand what is the use of rigging up for one hundred a day if there is only a market for ten? All these factors and a few more have a direct bearing on the cylinder casting industry. Green sand molding requires the highest type of skill, supervision and equipment to make it a commercial success. The equipment represents a large amount of tied-up capital and it takes time to develop the skilled help necessary. Dry sand molding requires even more equipment for in addition to that which is necessary for green sand work, at least two sets of flasks have to be provided. One set is in use while the other is either in the oven or on the pouring floor. The dry sand method, however, has an advantage in that it insures against casting losses due to improperly tempered sand. The metal in this class of castings is so thin that the least extra dampness in the sand will cause a blow hole or a cold shut. Here are two methods of making cylinders, both perfectly feasible under certain circumstances and both prohibitive under other circumstances.



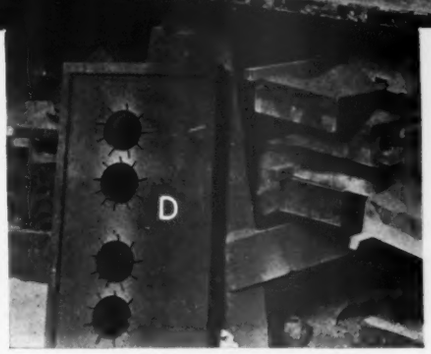


FIG. 1—A COMPLETE SET OF INTERIOR AND EXTERIOR CYLINDER CORES

As a compromise and as being particularly adapted to the requirements of his company, J. D. Wiseman, foundry superintendent, has devised a unique method for producing cylinder castings at the plant of the Buda Co., Harvey, Ill. This method has all the advantages of the dry sand practice without the attendant expense of providing iron flasks for the molds and cranes to handle them. Briefly, the cylinder molds are not molds at all, but cores. There are many advantages claimed for this system. Not the least of these is the ability to cast the cylinder barrels in a vertical position instead of horizontally.

Fig. 1 shows a complete set of cores both interior and exterior for one of the cylinder blocks made by this method. The body of the core, that is the part which corresponds to the mold, is divided into four parts for convenience in making and assembling. *A* is the drag or bottom, *B* and *C* the cheeks and *D* the cope or cover-core. Fig. 2 shows a floor of molds partly

FIG. 2—ASSEMBLING THE CORES—SINCE THERE ARE NO FLASKS THE WORK IS LIGHT AND EASY TO HANDLE

FIG. 3—A FLOOR OF MOLDS SHOWING THE METHOD OF MAKING UP THE RUNNERS

assembled. To facilitate assembling, a pair of level and parallel rails are provided on each floor. On these rails a row of bottom plates the proper dimensions for the job in hand is put down. As may be seen from Fig. 2 the cores are first fitted together on improvised benches, placed at a convenient height for the men working on the job. One man attends to the drags, another the cheeks and a third puts on the covering core, makes up the runners and daubs the joints.

The drag *A*, Fig 1, is first set on the plate and the water jacket *E*, Fig. 1, and other small cores set. The two parts of the cheek *B* and *C*, Fig. 1, are joined back to back inversely from the way they appear in the illustration. They are made in halves for convenience and also to save sand. It will be noted that *B* carries core prints on each of

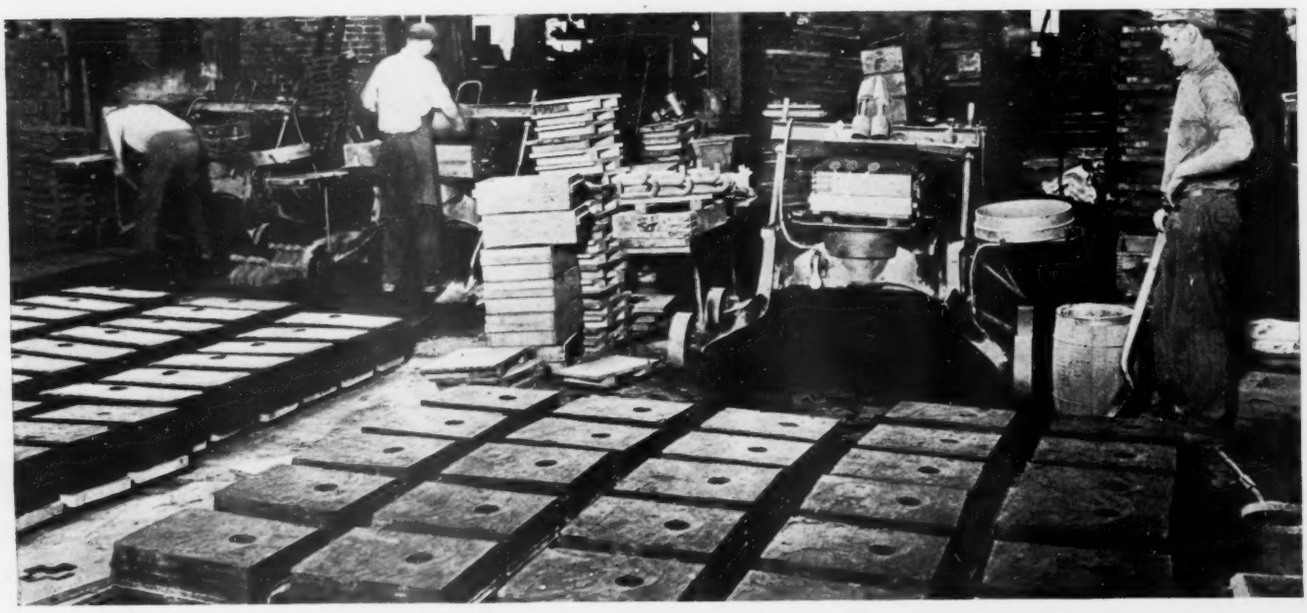


FIG. 4—ONE OF THE STRAINER CORES SHOWN AT A IS USED IN EACH OF THE SNAP MOLDS

FIG. 5—A CORNER OF THE CORE ROOM—GIRLS AND MEN WORK HERE ON TERMS OF PERFECT EQUALITY

the four sides. These correspond to the core prints in the drag and are for the double purpose of locating the jacket core and the cheek when closing the mold. All this extra body of sand is dispensed with in core *C*. The difference in bulk between the two cores is more apparent in Fig. 2. The two half-cheek cores are placed together, calipered for size and the joint inside the barrels daubed with a mixture of plumbago and oil. The complete cheek is then placed on the drag where it is automatically located by the prints previously mentioned. In addition to the regular prints two special recesses are formed, one at each end. These are clearly shown at *X X* on core *A*, Fig. 1. A round plug or templet of an exact size is tried in these holes when the cores are together and insures accuracy of position both horizontally and vertically. The barrel

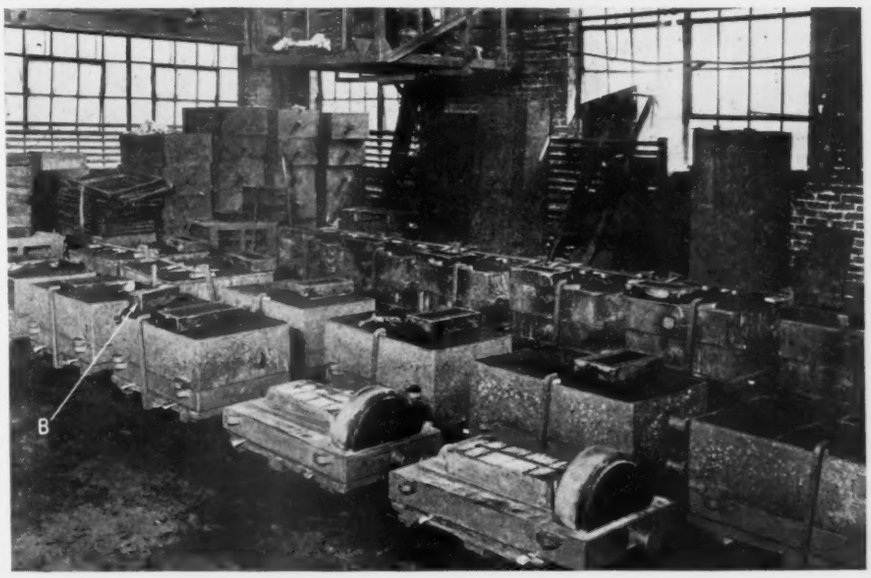


FIG. 6—A FLOOR OF LOWER CRANK CASE OR OIL PAN MOLDS—BLOCK B MAKES THE BASIN

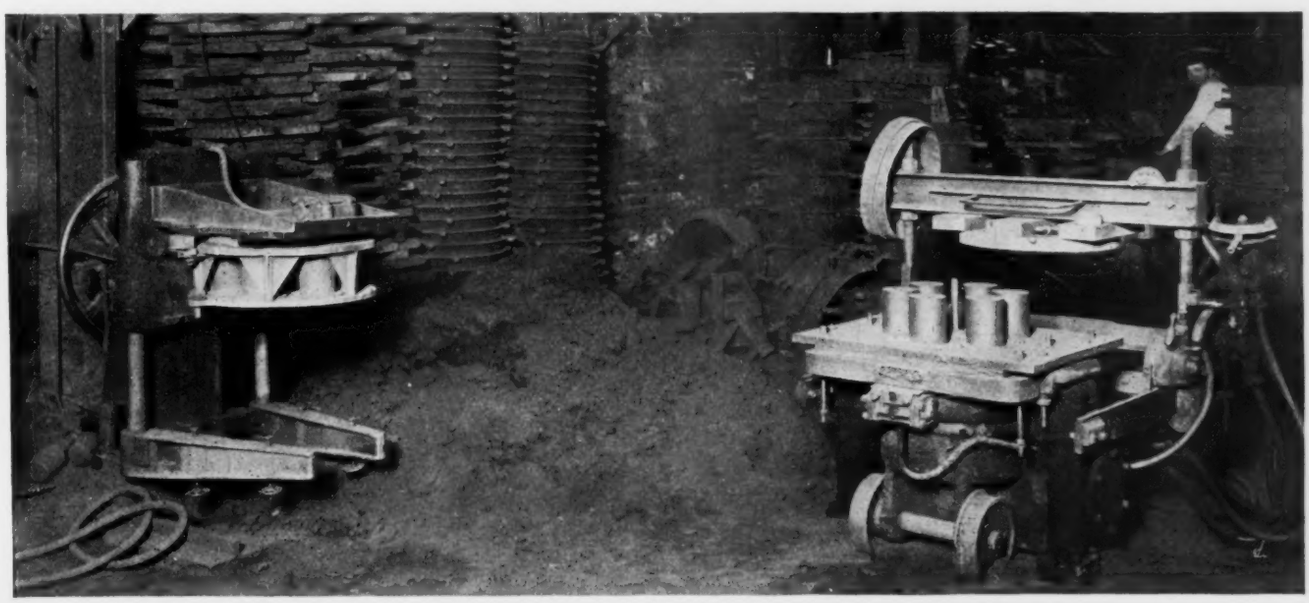


FIG. 7—A COMBINATION ROLLOVER, STRIP AND DRAW SQUEEZER MACHINE FOR MAKING PISTON MOLDS

cores *F*, Fig. 1, are then lowered into place and the covering core or cope *D* set on. This core as may be seen from the illustration is located by a male and female joint.

The system of gating the cylinders is also shown in the same illustration.

FIG. 8—THE DRAGS ARE MADE ON A HAND RAM POWER ROLLOVER, PATTERN-DRAW MACHINE

There are ten gates, each 1 x ¼-inch around each barrel coreprint. By their shape and size they constitute a natural strainer while their number insures a quick and at the same time an even distribution of metal to all parts of the mold.

In making up the runners different styles of basins are adopted, depending on the number of sprues to be fed. One method is shown in Fig. 3. An iron frame is placed on the assembled core and a cup core is located over each sprue. The space around the cup cores is then filled with sand. These molds are arranged to be poured from two ladles. In the case of the molds illustrated in Fig. 2, however, the iron frames *G* are placed on top of the core and a suitably shaped block to cover all the sprues is set on. Molding sand is packed all around the block. When this block is taken out there is left a long narrow basin with an extension at one side for convenience in pouring. A single ladle is used for pouring these molds.

After the castings are poured they are taken, just as they stand, and loaded upon electric trucks. They are first taken outside the building and dumped on an iron floor. Here the outside core is knocked off and shoveled into a sand reclaiming installation manufactured by the W. W. Sly Mfg. Co. of Cleveland. It is claimed that fully 90 per cent of the sand is recovered and fit to be used again. From the reclaiming hopper the castings are carried to the core room in an electric truck having a box mounted on the platform.

Cores enter so extensively into the molding methods of this shop that it is not surprising to find nearly one-third of the total floor area given up to, and one-third of the total force engaged in their production.

Girls form nearly half of the core-making force but there is no attempt made to segregate them or maintain a separate establishment for their benefit. They work with the men upon equal terms. It is claimed that it is all a matter of shop discipline, and that there is no more incongruity in men and women working together in a foundry than there is in a store or in an office.

Oil sand is used throughout for core sand mixtures. It is mixed in two cylindrical mills manufactured by the Standard Sand and Machine Co., Cleveland. A 6-foot Simpson grinding pan is used for mixing green sand facing for the molders. The cores are mostly made by hand but there are two hand jolt, pattern draw machines for making the cylinder cores. These were built by the Cleveland-Osborn Co., Cleveland. Ample facilities for drying the cores are provided for in eight gas-fired ovens, 8 x 8 x 12 feet.

All the castings in this shop are poured through skim gates. At *A*, Fig. 4, may be seen the style of strainer core used on all the bench work. The gate pin used in the snaps has a shoulder 1½ inches from the top. When the gate pin is drawn out one of these strainer cores is dropped in. It rests on the shoulder made by the gate pin and being a tight fit needs no further securing.

Fig. 6 shows a floor of crankcase molds. These are poured through 10 ¾-inch round gates set directly on top. The surface around the gates is sleeked before the cope is put on the drag. Then the block *B*, Fig. 6, is set on so that the gates are near one end, the runner box is put on and made up and the block taken out. Dirt is prevented from entering the mold by keeping the basin full while pouring. These molds are made on two Osborn, roll-over, pattern draw machines. The illustration, Fig. 8, shows one drag on the car awaiting the crane to place it on the floor shown in Fig. 6. Another drag has been rammed, turned over and is now ready to be

FIG. 9—THE LABORATORY, WHERE A CLOSE CHECK IS KEPT ON ALL THE MATERIAL ENTERING INTO THE COMPANY'S PRODUCTS

lowered and the pattern drawn. There are 17 Osborn machines in use in this shop altogether. They are all rollover draw, but are rammed by hand. In addition there is one special Osborn squeezer, rollover draw machine for making pistons. Fig. 7 shows the floor, machines and flasks for this job. These pistons are 4¼ x 5½ inches. With this outfit four men make 700 castings a day.

For melting the iron there are two No. 7 Whiting cupolas. They are used on alternate days and by this means are much easier taken care of. A close supervision is kept over the iron used in the foundry as well as the other materials which enter into the construction of their engines and for this purpose a well equipped laboratory is maintained. This company does all its own forging and heat treating of steel parts.

Making Iron Castings by the Lost Wax Process

AN especially interesting article was published in the February, 1911, issue of THE FOUNDRY describing the methods pursued at Naples, Italy, in producing copper-alloy castings by the lost wax process. The January, 1919, number contained an article touching on this method, but dealing more particularly with ornamental bronze casting methods as practiced in this country. Both of these articles dealt with the production of castings on a commercial basis.

FIG. 1—ASH TRAY—THE BELLS WITHIN THE CASING CAN BE ROLLED AROUND BUT ARE TOO LARGE TO BE TAKEN OUT

Albin Eckhart, of San Francisco, makes a hobby of this kind of work and has developed a sand mixture which enables him to pour the castings in iron. He makes his wax patterns in plaster molds; then runs the wax patterns up in sand molds, in which, after the wax has been melted out, the castings are poured.

Considering the process step by step, he first takes the object to be reproduced and makes a plaster mold by surrounding it with liquid plaster of paris, provision being made at the necessary places for taking the mold apart by what are generally known as draw-

FIG. 3 — LION CAGE—THE PADLOCK ON THE DOOR AND ONE OF THE LIONS ARE LOOSE

backs. After the plaster has set, the various joints are marked to facilitate reassembling; then the mold is taken apart, the pattern removed and the mold assembled again. It is then filled with melted wax. When the wax has set the mold is taken apart again and the wax pattern is removed. The plaster mold may be used indefinitely.

The wax pattern is now examined and any fins or blemishes are attended to. Then it is rammed up in ordinary fine molding sand in a small round iron flask. This flask is made in sections, each section being 2½ inches high. The number of sections used depends on the height of the proposed casting. After the flask has been rammed up, it is bolted together and placed in the oven to dry. The heat melts the wax. Some of it runs out the bottom through channels which have been provided when making the mold and the rest of it is absorbed by the sand and then evaporated, by the intense heat, of the oven.

The mold is poured through one runner which is connected inside to as many gates as are necessary to carry the metal to all parts of the mold.

Since it is not necessary to take the mold apart to remove the pattern, the most intricate shapes can be produced by this method without joints or fins of any kind showing on the casting. The accompanying illustrations show some examples of Mr. Eckardts' work.

These patterns were not all made in one piece. Instead each part was molded separately in plaster, cast in wax and then the several wax pieces were fastened together by heating the points of contact. For instance, Fig. 1 shows an ash tray 7½ inches high and 7 inches across at the widest place. The top and bottom pieces were molded from small cut-glass dishes and the ornamental scroll work was stamped out of sheet wax. After all the component parts were made, they were assembled and fastened in place. Then the complete pattern was rammed up in the sand in the manner already referred to.

FIG. 2—VASE MADE BY THE LOST WAX PROCESS FROM PATTERNS MODELED IN WAX AND FITTED TOGETHER

Firm Name Stated in Error

In describing the shop equipment of the Electric Steel Co. of Chicago in our issue of June 1 the Standard Sand and Machine Co., Cleveland, was credited through error with supplying the sand mixing machinery. As a matter of fact the three pans in use are No. 2 Simpson Mixers each 6 feet in diameter and were supplied by the National Engineering Co., Chicago. One of these pans is fitted with an automatic bucket conveyor, which considerably improves the operating efficiency of the machine.

Bill Talks on Cranes

By Pat Dwyer

COMING out of the public library the other night I met Bill who was just sauntering past. He was all trimmed up like a Christmas tree from a nifty panama to long tan shoes and white socks, he was like one of those fellows whose pictures are to be seen on the inside covers of our leading magazines. You know the lads I mean, they generally have a wolfhound near them, or else they are depicted anxiously scanning the horizon with a pair of field glasses gripped firmly in both hands. Another mark of identification is their moustache. This delicate little ornament is about the size and shape of the business end of a second-hand tooth brush. Their clothes fit them like the paper on the wall—no more, no less. Bill does not wear a moustache, and he draws the line at carrying a pair of field glasses or a cane; but otherwise he goes the limit. I believe he could get a job with the house of Luckyheimer any time as a demonstrater.

I offered him a cigar and attempted to link arms with him. He accepted the cigar but declined the little demonstration of familiarity. He said that this linking arms business was liable to arouse curiosity and perhaps cause comment now that the country had gone dry. I explained that my brother-in-law, who had just returned from Europe, had assured me that it was quite the custom over there for men to walk arm in arm. He said that European customs did not appeal to him. He had to leave a European country when very young on account of intolerable conditions and his opinion of Europe was the same today as it was the day he left with nothing but the price of a ticket, which he had borrowed, and the clothes on his back.

"I don't take much stock in this patriotic stuff," said he, "unless there is something to back it up. To my mind the country that is fit to live in is the country that is fit to die for; and the country that is not fit to live in, why, the people should get out and let it go to ——."

As I remarked before Bill is right careless in the use of words that are generally used sparingly by clergymen and others who are supposed to realize their deeper meaning. We strolled along and I explained to Bill that I had been spending a quiet half hour in the library.

"Anything special in there?" said he.

I told him it was a favorite refuge of mine.

"Refuge is good," said he. "A library is surely the last place on earth any one would think of looking for a molder."

I told him that I had been reading a poem that I had not seen for several years, "Greys Elegy in a Country Church Yard."

"I have not seen it for several years either," said he, "but I am not losing any sleep over the fact."

"The last time I read that poem," I said, "was when I was going to school. Taking it as a whole it was not bad; but we were not allowed to take it as a whole. The verses were doled out to us one at a time and we had to parse them, and analyze them, turn them end for end, and render them into prose. I am firmly convinced that we took more liberties with, and rung in more changes on, that piece of poetry than the author and rightful owner himself ever would have thought possible. It is an old favorite with school teachers. There is not a schoolmaster or mistress today but has at some time or another drawn his or her reluctant pupils' attention to the fact that the words in the line 'The tired plowman homeward plods his weary way,' may be transposed in 27 different ways and still mean the same thing.

"I did not like it at that time partly on account of the mental gymnastics involved and also because I was too young to have any conception of the great truths of life. I don't know much about them yet, for that matter, but I read the poem again tonight in the library and I found myself in accord with the author. The quiet and stillness of the place and certain memories which the words called up of two little lonely graves in a far distant alien land may have had something to do with changing my point of view. A library is a good place to go when you want a rest or to feel melancholy and when it comes to a place for a couple of hours quiet reading, why there is no place like it. If you have ever tried to read a book and at the same time listen intelligently to your wife so as to know when to say 'yes' and 'no,' without exciting her suspicion, you will know exactly what I mean.

"That is why I like to go to the library occasionally. The quiet, restful atmosphere acts as a sedative. A person can sit there all day and not be disturbed by people talking. The attendants glide around on rubber soled shoes and even the chair legs are tipped with rubber. There seems to be a mutual air of deference among the people who frequent a library, 'please do not disturb me and I will not bother you.' How different it is from other places you go to spend your leisure time where every one thinks only of himself and cares not whether he steps on any one else's

A LIBRARY IS NO PLACE TO HUNT A MOLDER

corns. Here you find mutual consideration."

"The place may be allright," said Bill, "but it sounds too quiet for me. I would go to sleep in a joint like that. I like to see people around me with some evidence of life in them. Whenever I go into one of these libraries it makes me think of a foundry on Sunday. Now my idea of taking a rest is to attend a ball game. With an unlimited supply of pop bottles and the home team winning, Oh, boy! that's what I call life.

"I don't mean by that that I want to spend all my time attending ball games—not at all—I am one of the old brigade. When we work, we work hard; and when we play, we play hard. There is a limit and a place for everything. There is also a right way and a wrong way to do everything. Some seem to think that as long as they get something done, it does not matter how they accomplish their purpose. I worked for a concern one time that operated its own foundries. The iron and brass foundry was in one building but the steel foundry was located in one end of the open-hearth building. In the course of time I became familiar with open-hearth practice and the feature that stood out most in my mind was the reckless disregard they had for machinery of all kinds. Everything was driven to the limit.

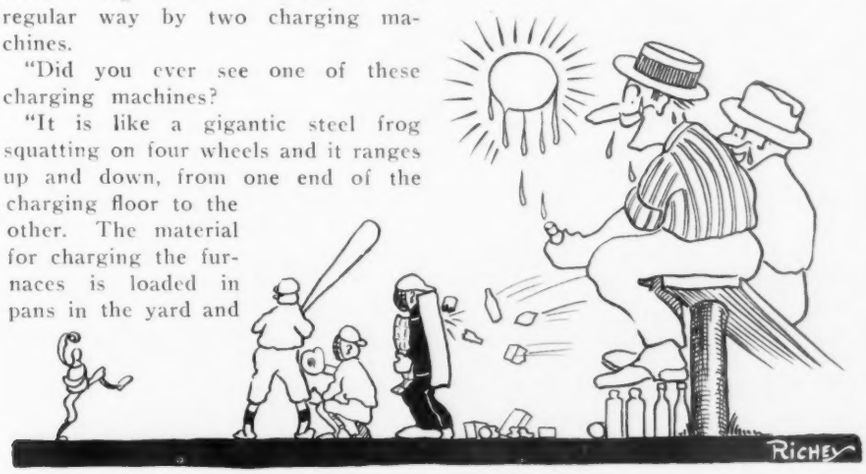
"The open-hearth building was 820 feet long and housed ten 50-ton furnaces of the tilting type. They were set level with the floor which made it necessary to have a pit in front of each one into which to lower the ladle while tapping the melt. They were charged at the back in the regular way by two charging machines.

"Did you ever see one of these charging machines?

"It is like a gigantic steel frog squatting on four wheels and it ranges up and down, from one end of the charging floor to the other. The material for charging the furnaces is loaded in pans in the yard and brought to the charging floor on narrow gage cars, each holding from three to five pans. When a furnace is to be charged the charging machine glides into position, a hollow steel ram shoots forward like a frog darts out his tongue when catching flies and engages the end of the pan, lifts it up clear of the car, runs on out until the pan is fairly inside the furnace. Then the ram rolls over like a log in the water and the contents of the pan are dumped on the furnace hearth. The ram then is rolled back into position, withdrawn and the pan set on the car again. In front of the furnaces were three pouring stands. The pouring ladle hung stationary on the crane while pouring the steel. The ingot molds were shunted in and out of the mill by narrow gage locomotives and the molds were spotted in turn under the nozzle by a hydraulic car pusher.

THE BOSS MELTER LOOKS THEM COLDLY IN THE EYE

"On the same side of the building was a standard gage track on which hot metal was brought in from the blast furnaces and cinder, slag, skulls, scrap, burnt-out brick work and the rest of the mess which is daily produced in an open hearth was hauled away. Under these circumstances it was only natural that frequently when the time came to tap a furnace, a train of cars or hot metal ladles would be in the way and no locomotive would be available.



AND THE HOME TEAM WINNING—OH BOY!

"You have been around steel mills and you know that when a heat is ready to tap the boss melter does not sit down to a game of solitaire. The mill runs on a double shift and the efficiency of each shift is determined by the number of heats tapped. Consequently, in a case like the one mentioned, the nearest crane is requisitioned, the auxiliary hoist hooked on to the draw bar of the car which is in the way, the first helper yells, 'Drive 'er Jimmy, atta boy.' The crane travels down the mill and the way is made clear. The millwright raises a row, the chief electrician raises a bigger one and both claim that this is no way to use a crane. The car repair man kicks in and claims that this 'strong-arm stuff' is ruining his draft gear. Then the boss melter takes off his blue glasses, looks them all coldly in the eye and tells them that when he whistles up a heat he is going to tap it.

"Now, mind you, I am not defending the method, for to be strictly truthful I have often given the crane man a 'high ball' myself; but what I wanted to tell you about is how a crane can be used to pull cars in a perfectly legitimate way.

"In the iron foundry of the same plant it was the custom to push the cars into the core ovens with pinch bars. You know what a slow heavy job that is. Sometimes the bar slips and then someone's fingers are pinched between the bar and the rail.

"For pulling the cars out of the ovens one of the cranes would be hooked on, then when the slack of the chain was taken up the carriage would be racked in. The only objection to this method was that sometimes, instead of moving horizontally the front of the car would rise up and the wheels jump the track. Finally

we rigged the cars so that the crane could pull them either in or out of the ovens without either racking in the carriage or traveling up or down the shop. We had eyebolts screwed to the ends of each car and also into the brick work at the back of each oven. A sheave wheel was hooked on to each of these wall eyes. Then a ¾-inch wire cable was reeved through each sheave, one end secured to the eyebolt in the car and the other end reeved through a sheave anchored to a *deadman* at the end of the core oven track. That cable was for pulling the car into the oven. The cable for pulling the car out of the oven was hooked onto the outside end of the car and then passed through a sheave anchored to the same deadman. The deadman in each case was a wornout roll from the rail mill, buried about 3 feet deep and each had a wire sling around the middle to which to fasten the sheaves. After that, whenever it became necessary to pull the cars either into or out of the oven, the crane was hooked onto the proper cable, the crane man pulled back his hoist control and pulled the load vertically through the cable to the sheave. Even the chief electrician could find no fault with the idea or nothing to kick about; and when the chief electrician is satisfied you are quite safe in assuming that 'God's in his heaven and all's well with the world.'"

British Foundrymen Incorporate

Coincident with its incorporation under royal charter, the British Foundrymen's association has changed its official title to the Institute of British Foundrymen. Recently the Birmingham branch of the association has held joint meetings with the Staffordshire Iron and Steel institute and other technical societies, and it was proposed to link the various organizations through their governing councils. This proposal did not recommend itself to the foundry body, which suggested as an alternative measure the co-operation of the several secretaries in the preparation of session programs.

The Birmingham branch of the Institute of British Foundrymen recently adopted resolutions condemning the action of the British Engineering Standards committee in fixing the physical tests and also complete chemical requirements for cast-iron products. The resolutions called upon the council of the national association to appoint a committee to deal with the subject of cast-iron specifications. Following this action the general council of the national organization invited each branch to nominate a representative on an advisory subcommittee to deal with the subject.

Reorganize to Promote Standardization Work

The American Engineering Standards committee has just completed and adopted a revision of its constitution which has been sent to the governing boards of all the government departments and societies represented on the committee with a request for its ratification. The new constitution changes the name to the American Engineering Standards association. The objects of the association are to unify and simplify the methods of arriving at engineering standards; to secure co-operation between various organizations; to prevent duplication of standardization work; to promulgate rules for the development and adoption of standards; to revise and pass upon recommendations for standards but not to initiate, define or develop the details of any particular standard; to act as a means of intercommunication between organizations and individuals interested in the problems of standardization; to give an international status to approved American engineering standards; and to co-operate with similar organizations and individuals interested in the problems of standardization.

Any organization may request the association to approve standards which it has formulated or to approve committees that it has appointed and by so doing becomes a "sponsor" society. Such a request is entirely at the option of the organization that has formulated or expects to formulate the standard. At the request of the "sponsor," approval of the standards is given when they are the substantially unanimous conclusions of a committee made up according to the nature of the standard. Committees dealing with standards of a commercial character, such as specifications, shop practices, etc., shall be made up of representatives of producers, consumers and general interests, no one of these interests to form a majority.

The approval of the association may be given in one of three ways, as "Recommended Practice," "Tentative Standards," or "Standards," the expectation being that nothing will be approved as standards until it is shown that it is generally acceptable.

In the past there have been many occasions when two or more organization have formulated standards for substantially the same thing. Often these differences have been very slight but neither has been quite acceptable to the other party. In the majority of such cases, if these organizations had been brought together at the start they could have agreed on a standard that would have been satisfactory to both. The American Engineering Standards association will furnish a means by which any organization intending to define its standards can readily ascertain what others are interested and should be consulted in regard to it. The association provides definite machinery for securing co-operation and preventing duplication of work. It establishes definite rules securing the absolute autonomy of any group engaged in the development of standards and insures that this group shall receive due credit for its work.

New England Foundrymen Discuss Business Problems

In spite of labor difficulties, high prices of iron and the prospect of a coke shortage there is a cheerful tone among New England foundrymen. It was manifested at a recent meeting of the New England Foundrymen's association at the Exchange club, Boston. Many foundrymen said they believed it wise to buy iron, coke and scrap to cover the balance of the year's requirements at the present time, the only difficulty being to determine what the requirements will be. Although foundry business has been increasing during the last month it has been spasmodic and it is hard to foresee future needs.

Some uneasiness over the labor situation was manifested. "This condition is to be expected," said one foundryman from Rhode Island. "Men who enjoyed high wages and unusually favorable conditions during the war cannot be expected to calmly accept lower wages and less pleasant conditions without a protest. The adjustment of the labor question is a matter of time and education."

On invitation from the Providence, R. I., members, the next meeting of the association will be held in that city on the second Wednesday of August.

The Chicago offices of the International Oxygen Co., Newark, recently were removed from the Railway Exchange building to 817-820 Stock Exchange building. Philip G. Wesley is in charge.

Pawling & Harnischfeger Co., Milwaukee, crane builders, has opened a western office in the Monadnock building, San Francisco. Robert M. Taylor is manager.

Modern French Foundry in Suburbs of Paris

Details of Interesting New Plant Equipped With Hydraulic Molding Machines—Melting Apparatus Has Special Features

By H Cole Estep

FRENCH foundry practice, which was highly developed before the war, made great strides during the conflict owing to the tremendous demand for high grade steel castings for artillery and for semisteel shells, iron hand grenades and other forms of cast ammunition. The foundries of France also were called upon to turn out castings for a large amount of miscellaneous machinery of all kinds during the war. Inasmuch as a large number of the 2500 foundries in France were in the invaded district, an unusual strain was thrown on those in the vicinity of Paris and elsewhere not affected by military operations. To meet this situation, a great many new plants were constructed and with characteristic French foresight a substantial proportion of them were designed and built with the permanent needs of the country in mind. Prominent among those in this category is the new foundry of Ph. Bonvillain & E. Ronceray at Choisy le Roi, a suburb of Paris on the Seine, a few miles east of the walls of the city. This plant is known as the Mafo works.

The firm of Ph. Bonvillain & E. Ronceray is one of the most widely known concerns in the foundry industry in western Europe. In addition to the Mafo works, which turns out gray iron and semisteel castings for the company's own use and for general consumption, another large plant is operated at Villa Faucheur, Paris, for the manufacture of molding machines, cupolas, sand mixing machinery and other forms of foundry equipment. The company has a capital of 1,200,000 francs. The officers are well known in foundry circles in Great Britain and western Europe. Philip Bonvillain is chairman of the board of directors, E. Ronceray, president and J. M. Espana, director general. The company does business throughout the world and its plants are equipped to manufacture a complete line of foundry equipment and supplies.

The foundry at Choisy le Roi is a brick and steel structure of modern construction. It is provided with a saw tooth roof of tile and glass and the interior is unusually well lighted. A general view of the interior is shown in Fig. 1, which illustrates the arrangement of the molding machines and floors. The two bays into which the molding room is divided, are served by light traveling cranes and an overhead monorail system. The plant is located between the main tracks of one of the French trunk line railroads and the Seine on a level plat of ground which slopes up slightly toward the railroad. This elevation makes it possible to switch cars into the plant on the cupola charging-floor level. A warehouse for the storage of miscellaneous equipment and supplies also has been erected on this level alongside the tracks. Two 30-inch cupolas have been provided for melting the metal. The molding department is equipped with a large number of hydraulic molding machine of various sizes built by Bonvillain & Ronceray. The sand handling, cleaning and other departments also are equipped with unusual thoroughness. Ample room for future expansion has been provided.

The system of molding developed by Bonvillain & Ronceray involves the use of hydraulic squeezer machines usually equipped with stripping plates. For flasks up to approximately 30 inches in diameter, pushing out machines, hydraulically operated, also are employed for pushing the entire mold out of the flask before it is set on the floor. This arrangement

FIG. 1—A PORTION OF THE MOLDING FLOOR OF MODERN FRENCH GRAY-IRON FOUNDRY EQUIPPED WITH HYDRAULIC MOLDING MACHINES

FIG. 2—THE MAN AT THE RIGHT IS MAKING A SMALL DYNAMO PART ON A HYDRAULIC SQUEEZER MACHINE, WHILE THE WOMEN AT THE LEFT ARE STRIPPING THE MOLD OUT OF THE FLASK PRIOR TO SETTING IT ON THE FLOOR

obviates the use of a large number of flasks.

As described in THE FOUNDRY, July, 1913, Bonvillain & Ronceray also have developed an especially interesting type of machine which fills both the cope and drag flasks with sand simultaneously and rams the two parts of the mold at one stroke. The pattern is also drawn by the machine and the mold closed and pushed out of the flask. Barred flasks can be employed with this type of machine. It is designed especially to eliminate fins on light work which results from the improper matching of the cope and drag halves of the molds. The pattern plates employed on this machine are cast in carefully made molds and in special flasks provided for the purpose. During the time the mold is being rammed, the pattern plate is without lateral fastenings, being guided only by the flask pin. Since barred flasks can be used, comparatively shallow molds can be employed even though their dimensions are relatively large. This eliminates the necessity of weighting the molds for pouring in a horizontal position or the use of clamps when pouring on end.

The operations of the plant at Choisy le Roi may be said to commence with the patternmaking and matchplate department, a portion of which is illustrated in Fig. 15. This department is equipped with special iron benches the tops of which are accurately surfaced. Bins also are provided for storing sand, cement, etc., and a furnace has been installed

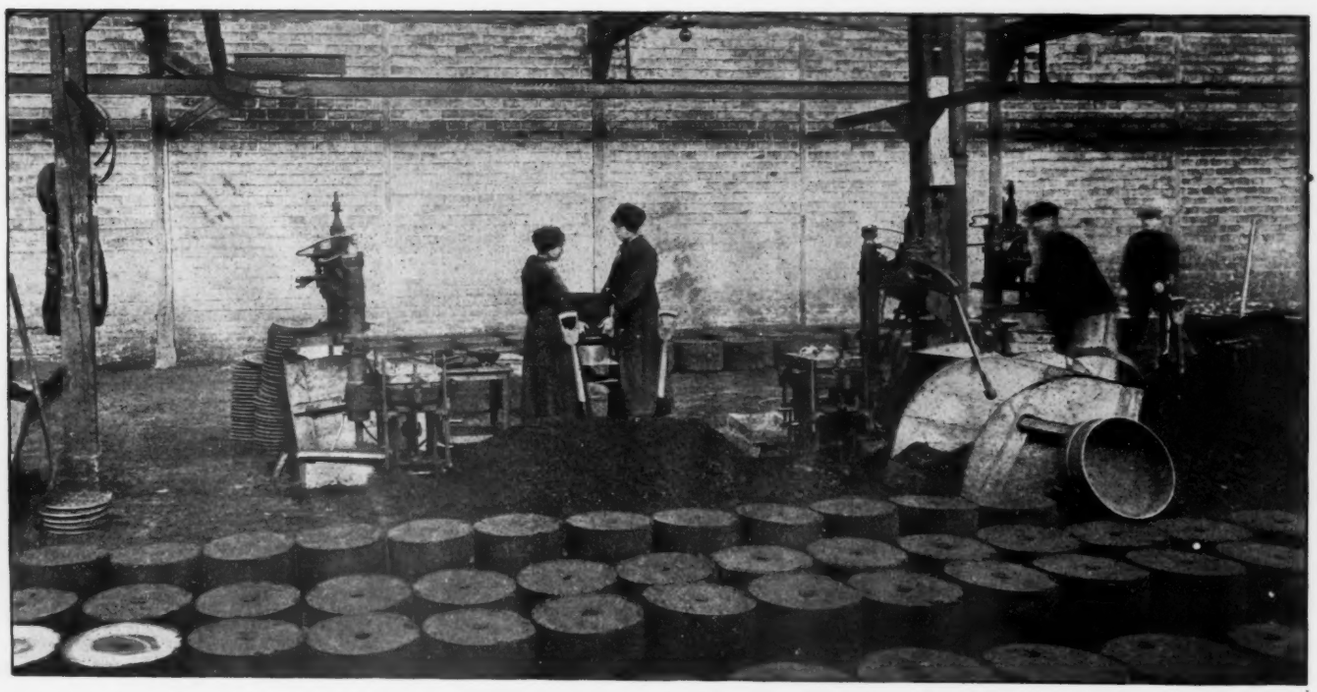
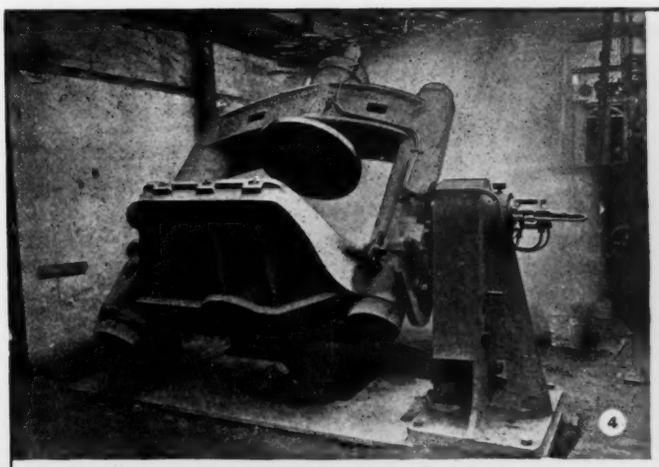
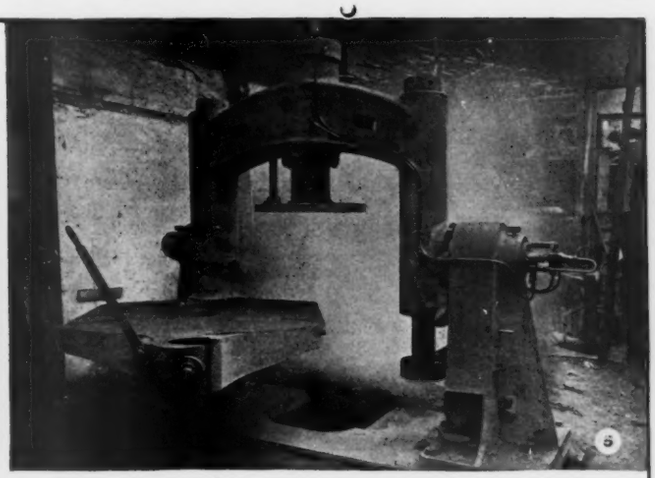


FIG. 3—ANOTHER PORTION OF THE MOLDING FLOOR SHOWING MACHINE EQUIPMENT, PORTABLE WOODEN BOX FOR HANDLING SAND AND OVERHEAD MONORAIL





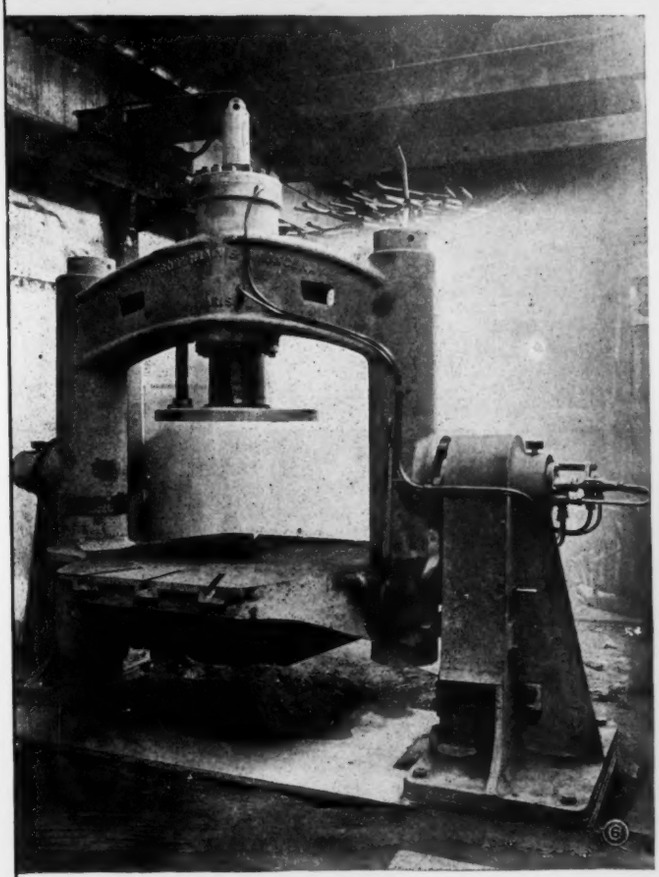


FIG. 4—LARGE HYDRAULIC ROLLOVER MACHINE IN TILTED POSITION FIG. 5—LARGE HYDRAULIC MACHINE WITH TABLE SWUNG OUTWARD FIG. 6—LARGE HYDRAULIC MACHINE READY TO RECEIVE FLASK FIG. 7—SAND MULLER FITTED WITH SPHERICAL CAST-IRON CAGES FIG. 8—A CORNER IN THE SAND-MIXING ROOM SHOWING THE MIXER, DISINTEGRATER AND ROTARY RIDDLE FIG. 9—GENERAL VIEW OF MOLDING FLOOR

FIG. 10—A PAIR OF MOLDING MACHINES TURNING OUT BRAKE SHOES—IN THE LOWER LEFT FOREGROUND ARE SHOWN A PATTERN-PLATE AND STRIPPING-PLATE FOR A VISE

for melting the white metal pattern-plate and matchplate mixtures. The latter are made out of an alloy of lead and antimony. The pattern plates are carefully made from master patterns by workmen who are almost artists. As previously mentioned, a large number of stripping plates are used in connection with the molding machines. These are about ½-inch thick and the outline of the pattern is cast with a knife edge which makes it possible to cast the plate in with sufficient accuracy so that machining is unnecessary. This considerably reduces the cost of making the plates and it, therefore, is possible for foundrymen using molding machines of the Bonvillain & Ronceray type to make their own stripping plates at nominal expense. A clear view of one of these plates is shown in the left foreground of Fig. 10 near the molds.

The molding department is one of the most interesting features of the Bonvillain & Ronceray foundry, on account of the unusual variety of work turned out and the interesting character of the equipment. The floor is divided into two bays or aisles separated by a row of columns in the middle of the building. The molding machines are arranged in a row down the center of the shop parallel to the line of columns, as shown in Fig. 9. Floor space, therefore, is left on both sides of the machines for setting out molds and the maximum distance which molds have to be carried is thereby reduced one half. The machines are placed alongside a covered trench which runs the full length of the shop and contains the high pressure hydraulic piping. The machines are all of the Bonvillain & Ronceray hydraulic type, using water at 700 and 1500 pounds per square inch. One small hydraulic pump furnishes sufficient power for operating the entire battery of machines. An accumulator of suitable size is included in the hydraulic system. The machines are of the hydraulic squeeze and stripping-plate type and also of the squeezer and rollover type. In the latter case they are so mounted that the whole machine rotates in suitable trunnions.

FIG. 12—A PORTION OF THE CLEANING ROOM SHOWING THE GREAT VARIETY OF CASTINGS MADE IN THESE FOUNDRIES

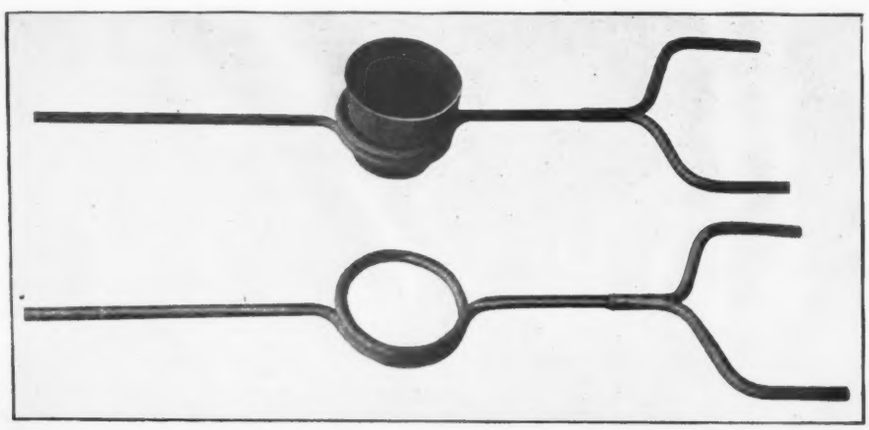


FIG. 11—HAND LADLE WITH TUBULAR SHANK USED IN HANDLING THE METAL FROM THE FURNACE LADLE TO THE SMALL MOLDS

Many of the small castings are made in round snap molds of the types shown in Figs. 1 and 3. In order to minimize the number of flasks necessary for this work, the molds, as previously mentioned, are pushed out of the flasks before being set on the floor by a hydraulically operated pushing out machine or stool shown at the left in Fig. 2. These machines are operated largely by women. The sand at the parting is held in place by light steel hoops which effectually prevent runouts. These hoops are

FIG. 13—THE CUPOLAS ARE SUSPENDED FROM THE CHARGING FLOOR BEAMS AND ARE EACH PROVIDED WITH THREE TAPHOLES

FIG. 14—A CORNER ON THE CHARGING FLOOR SHOWING ARRANGEMENT OF CHARGES WITH NUMBERED PLACARDS

FIG. 15—IN THE PATTERN-PLATE DEPARTMENT EACH MAN WORKS ON A SPECIALLY DESIGNED BENCH AND ACCURATE RESULTS ARE EXPECTED

set in place in the flask when the mold is made on the machine. They are clearly shown at *H*, Fig. 10. With the parting of each mold protected by hoops in this manner, it is not necessary to use mold jackets when pouring such as are usually employed in the United States.

On account of the extensive use of machines in this foundry, a large production is obtained from small floor space. An idea of a part of the day's work can be obtained by referring to Figs. 1 and 9. Fig. 3 shows two molding machines of the swing-head squeezer type together with a pushing out machine operated by women. At the right in this illustration is shown one of the open wooden sand boxes in which the sand is distributed to the floors by means of the monorail trolley system.

Small pulleys about 3 inches in diameter are made on a stripping plate machine with 10 castings in a mold. A

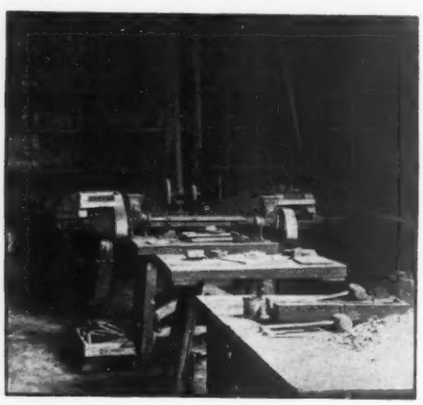


FIG. 16—A PORTION OF THE CORE ROOM SHOWING AMERICAN COREMAKING MACHINE

girl and a boy readily put up 200 molds a day. The cores are set by means of a wooden frame or gage which insures their being placed accurately and rapidly. The metal is poured through a horn gate. The copes and drags are symmetrical and, therefore, only one machine is employed for making these pulleys.

Molding Small Parts

Among the several interesting types of molding machines installed in the Choisy le Roi plant are those shown in Fig. 10 which are employed for molding brakeshoes and other similar castings. When poured the molds are held down by weights. As illustrated in Fig. 10, two brakeshoes are cast in one flask. There are two green-sand pivot cores and two dry-sand cores in each mold. Two molding machines are employed, one making the copes and the other the drags. Two young men operating these machines readily put up 130 molds per day. The castings weigh 35 pounds each.

One of the largest machines built by Bonvillain & Ronceray is shown in Figs. 4, 5 and 6. It is of the hydraulic squeezer type, similar in general to the smaller machines, but takes a flask about 5 feet square. The flask is rolled over by the hydraulic cylinder shown at the right, the entire machine, including the mold, frame and squeezing cylinder being rolled over together. These illustrations readily demonstrate the possibilities of the hydraulic molding machine for handling heavy work.

Care in Preparing Sand

In common with most other French foundries, special attention is paid to the preparation of the sand at the Bonvillain & Ronceray plant. The sand is not only ground and mixed in a muller type mixer similar to that shown in Fig. 8, which illustrates a corner in the sand preparing department, but it is aerated and disintegrated in a machine of the centrifugal type. The large lumps are screened from the sand by means of the rotary riddle shown at the right in Fig. 8. Fig. 7 also illustrates another exceedingly interesting type of sand muller built and used by Bonvillain & Ronceray. This machine, as the illustration indicates, consists of a heavy bowl-shaped casting inside of which a paddle revolves at a moderate rate of speed. Two spherical cast-iron cages, each about 16 inches in diameter, are placed loose in the bowl and revolved by the paddle arms. One of these cages is shown at *C*, Fig. 7. As they roll around inside the bowl, they grind and mix the sand at one operation. Seacoal is used in all of the facing sand. Some of the molds are dusted with talc as they are made, plumbago not being used for this purpose.

The cupolas, as shown in Fig. 13, are placed at one end of the shop. They are lined to 30 inches in diameter inside. Instead of being set on cast iron legs, as is customary in the United States, they are suspended from the charging floor beams. The space around the bottom doors is therefore absolutely free of obstructions. The cupolas are of the bessemer type, that is, they are provided with a bustle pipe and individual tuyere boxes. Each tuyere box is provided with a lever by means of which the size of the tuyere opening may readily be changed to suit varying melting conditions. As shown at *T*, Fig. 13, each cupola is provided with three tapholes at three different levels. Behind the two upper tapholes is an inverted bridge wall, through the medium of which a syphon effect is obtained in pouring, and in case the operator wishes to stop pouring all he has to do is to cut off the wind. Normally only the lowest taphole is used, but in case it is desired to pour much more rapidly, the upper two also may be opened.

The metal is distributed to the various floors throughout the shop by means of the overhead monorail system. Geared bull ladles of a standard type are employed for distributing the metal to the floors where it is poured into the smaller molds by hand ladles similar to that shown in Fig. 11. These ladles are carried in shanks which are made out of tubing bent to the proper shape, the forked handles, which also are tubing, being welded on one end. The ladle skulls are poured into pig molds which are shown at the lower left foreground of Fig. 13.

Fig. 14 shows a view of the charging floor with the coke bin at the left, and the passageway for bringing in pig iron, scrap, etc., at the right. Each separate charge is numbered and marked by means of a wooden label. The exact time when each charge is thrown into

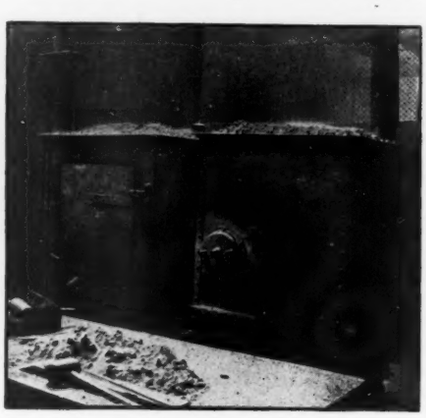


FIG. 17—CORE OVENS ARE OF A DISTINCTIVELY FRENCH TYPE

the cupola is noted on a report sheet which is sent to the general office every day.

The metal is mixed by analysis and usually two kinds of iron are poured during each heat, one mixture, rather high in silicon, being employed for general machinery castings and the other for brake shoes. Printed cupola charging sheets are used for keeping a record of the charges and mixtures, similar to those found in progressive foundries in the United States.

Other Departments Well Equipped

A completely equipped coremaking department and cleaning room have been provided.

A corner in the cleaning room is shown in Fig. 12. This illustration clearly indicates the wide variety of castings made at the Mafo plant. A portion of the coreroom is shown in Fig. 16. In addition to other equipment, this department is provided with two core machines furnished by the Wadsworth Core Machine & Equipment

(*Concluded on page* 437)

Reports Investigation on Bearing Metal Alloys

All Work in This Direction Without the Application of Modern Metallography is Characterized as Wasted by the American Society of Mechanical Engineers' Committee

RECENTLY the subcommittee on bearing metals, appointed by the American Society of Mechanical Engineers made a brief report giving the reason for abandoning the original plan for first publishing a complete compendium of technical literature on bearing metals. It was pointed out at that time that a large amount of valuable time is being wasted in testing bearing alloys, in determining characteristics that are of no consequence and are utterly meaningless. The only mechanical or physical test of a bearing alloy, in the aggregate, that can serve any useful purpose, is that of determining whether the given alloy has a sufficiently high factor of safety against possible distortion or rupture under specified service conditions at service temperature. All other characteristics are of a microscopic nature, depending entirely upon the properties of the individual crystals of the alloy, upon their orientation, relative hardness, fusing temperature, quantitative proportions and the like.

Studies have convinced the committee that any work on the subject without the application of modern metallography is an absolute waste of time; and that studying the hardness of the individual microscopic crystals is of the greatest importance in supplementing the application of metallography to the subject.

The instrument shown in the last report of the committee has been perfected to a much higher degree and three of them have been substantially completed, one for each member of the committee. This instrument determines the characteristic of a crystal which is the combination of three of the five fundamental conceptions of hardness: namely, the combined effect of cutting hardness, scratch hardness and penetration hardness. This is done by slowly moving an exceedingly hard and sharp point under a definite pressure, over a highly polished surface of the crystal to be tested; in fact, the point is moved so slowly that no additional penetration is effected by stopping. The point is a solid right angle or the corner of a cube, mounted in such a manner that the diagonal of the cube will be normal to the surface tested, and having an edge of the cube advance directly in the line of motion. The motion is effected by a slow micrometer feed. The width of the cut, scratch, or penetration is a function of its depth and, therefore, measuring the width of the mark gives the means for determining this combined characteristic representing the hardness of any crystal. The instrument is properly called a *microcharacter*.

In order to lay the broadest foundation for the work, one that will facilitate the co-operation of other investigators and will make all results directly comparable, it will be necessary that conventional units be established; that is, that a scale of *microhardness* be determined upon. With the establishment of this scale, it will be possible to consider the various crystals in the many different alloys in terms of exact degrees of hardness. This is the work that occupies the attention of the committee at the present time.

Experience well shows that a single homogeneous metal is not suited for bearing purposes, and that the first requirement for a bearing metal is that it be an alloy composed of at least two metals, or a metal and a metalloid, which shall have at least a limited degree of solubility while in the molten state; but that upon cooling it shall partially separate out into dissimilar crystals, and thus form the proper microstructure which is necessary in all bearing alloys. It is not only necessary that a bearing alloy shall be composed of chemically dissimilar crystals, but it is all-important that these crystals shall have a marked degree of difference in their physical hardness and wearing qualities.

The degree of relative solubility necessary for the constituents of bearing alloys is well illustrated by the copper-tin and the copper-zinc compounds, and this also illustrates why bronze is a better bearing alloy than brass. For example, with the addition of not more than 11 per cent of tin to copper, a three-phase alloy is ordinarily produced —less than a two-phase alloy cannot be produced; even with the most instantaneous chilling effect, crystals of different chemical composition are produced. While on the other hand, with 11 per cent of zinc added to copper, only a single-phase alloy can be produced, however slowly it may be cooled; that is, all of the crystals in this copper-zinc alloy are of the same chemical composition and, therefore, all have the same physical properties. Quite the opposite is true in the copper-tin alloy, an extreme dissimilarity of crystals existing both as to chemical composition and physical hardness. Now, it is due entirely to this dissimilarity of crystals in the bronze that makes it a better bearing alloy than the brass.

In the solidifying of the molten bronze the tendency of the tin to separate from the copper is far greater than that of the zinc in the solidifying of brass, for the reason that the bronze solidifies with a distinct microscopic heterogeneity. The matter of having a proper microstructure in a bearing alloy is always of far greater importance than its exact aggregate chemical composition. The value of an exact or definite chemical composition is secondary, in that it can serve only in producing the desired microstructure in a given alloy, provided the alloy is subjected to the proper cooling conditions.

The essential characteristic of all bearing alloys is a structure made up of alternately hard and relatively soft microscopic particles intimately mixed. The function of the hard particles or *bearing crystals* is to support the load and resist the wear. These bearing crystals should not be hard enough to

Light on Bearing Metals

Bearing metals is a subject upon which there is no general agreement based on scientific understanding, but what agreement there is in regard to this class of metals is founded almost entirely upon what has been learned through extended practical experience. On this account the accompanying report of a subcommittee on bearing metals of the American Society of Mechanical Engineers is interesting to foundrymen. This committee is trying to establish a scientific basis for studying the properties of bearing metals and to find out the best class of alloys for making bearings. The report was made at the spring meeting of the society, held in Detroit, June 16 to 19. C. H. Bierbaum, vice president of the Lumen Bearing Co., Buffalo, is chairman of the committee. The other members are J. A. Capp, chief of testing laboratory, General Electric Co., Schenectady, N. Y., and H. Diederichs, professor of experimental engineering, Cornell university, Ithaca, N. Y.

prove distinctly abrasive to the journal surface. General experience shows that an extreme hardness of the bearing crystals is characterized by an excessive wear of the journal. The function of the softer or more readily abraded crystals is that of being plastic and permitting the bearing crystals to adjust themselves to surface requirements of the journal. These softer crystals are also more readily abraded, and therefore wear slightly below the surface of the bearing crystals and thus form slight depressions upon the bearing surface which serve for the retention of the lubricant. However infinitesimal in amount this may seem, nevertheless it is this lubricant that prevents scoring or seizing when the journal is starting up from rest at a time when actual metallic contact between the bearing surfaces exists. The same is equally true under an excessive load. This function of retaining a slight quantity of the lubricant upon the bearing surfaces when metallic contact exists, characterizes a bearing alloy in its truest sense. Therefore a bearing metal may be defined as: An alloy that is capable of retaining a lubricant on a bearing surface.

In the operation of a bearing under normal conditions, when a continuous and unbroken film of lubricant exists it matters little what metals are used while the film is sustaining the entire load. In the starting and stopping of the journal, however, or at all such other times when the film is interrupted and metallic contact exists, it then becomes important that the properties of a bearing metal should be present.

Fusing Temperature Important

A matter of importance, which seems not to have been considered heretofore, is the fusing temperature of the bearing crystals. From observations made it is evident that under severe conditions where relatively low-fusing bearing crystals exist in a high-fusing alloy these bearing crystals actually fuse on their surfaces during the process of the "running in" of the bearing. The delta copper-tin crystal (Cu_4Sn) may be cited as a particular example, and in some severe conditions corresponding to automotive worm-drive service (Cu_3P) seems to function in a similar manner. It is doubtful whether these conditions ever obtain in any of the babbitts, since their bearing crystals are the highest-fusing compounds of these alloys.

The study of bearing metals is incomplete unless these alloys are considered in conjunction with the other corresponding bearing member. The extreme variety of modern steels makes this necessary, since a bearing alloy suited for a soft low-carbon machine-steel journal would not be an economic selection for the latter would prove destructive to the former.

It seems exceedingly improbable that laboratory accelerated service tests can ever give general satisfaction, owing to the difficulty of reproducing in a few hours' time the equivalent of many years of service conditions. It is the conviction of the committee that much more can be learned from the study of failures, and also in studying old bearings together with their journals, which have given eminently satisfactory service for an exceptionally long period.

Picture-Frame Fracture in Malleable Explained

IN a paper presented before the American Society of Mechanical Engineers at its spring meeting held in Detroit, June 16-19, Enrique Touceda relates the results of his research work on malleable iron. Picture-frame fractures and the causes which produce them are discussed in this paper. Attention is called to the fact that frequently low-silicon carbon-manganese malleable iron of certain compositions will yield what are known as picture-frame fractures, such as are shown in Fig. 1. These fractures are typical and have the following composition: Silicon, 0.54 per cent; phosphorus, 0.162 per cent; sulphur, 0.053 per cent; manganese, 0.108 per cent; total carbon, 2.01 per cent. This piece when polished and etched showed a decarbonized surface border, an inner ring of coarsely laminated pearlite, and within this a core corresponding in structure to that of normal malleable iron, all of which are characteristic of this grade of iron. Fig. 2 shows the decarbonized border surrounding the pearlitic ring, Fig. 3 the structure of the pearlitic ring, and Fig. 4 the core within the pearlitic ring. It is the presence of this ring of pearlite whose ductility is so much less than that of the metal in either the decarbonized border or core that produces on fracture the sharp line of demarcation between frame and core. While in this particular fracture the frame is fiery bright and finely crystalline and the core black, there are picture-frame fractures that show various color characteristics of frame and core, but it will be found that invariably the frame has its pearlitic ring of greater or less breadth.

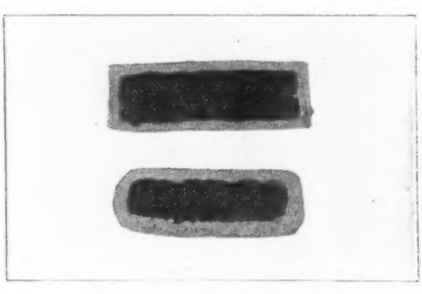


FIG. 1—PICTURE-FRAME FRACTURE IN LOW-SILICON CARBON-MANGANESE SPECIMEN

If the sulphur in the hard iron is unduly high and particularly if not well balanced by the manganese, the castings will almost invariably show a picture frame on fracture. This is especially true if the temperature of anneal is too high for such a composition. If the manganese is too high and not well balanced by the sulphur, the same result will follow. In each case there is an appearance to the frame and core indicative of which is which. The frames shown in Fig. 5 are rather typical of the latter. In these cases the frame is dove-colored, while the core is black but sparkling.

There are some compositions that unquestionably have frame-producing tendencies. These compositions will not produce a frame when annealed in an atmosphere that is not oxidizing. The surface structure of the hard iron has nothing to do with the problem. The writer has had ¼ inch ground off of one side of hard-iron samples and upon annealing these samples the frame was in evidence equally on all sides. It has been found that we can have ferrite that will elongate into very long spines and ferrite that will fail to elongate at all. We can have a pearlitic grain that can be ductile and those that are not.

The foregoing is stated because the writer believes that whether or not a frame will be produced in the fracture depends upon the breadth and ductility of the pearlitic ring. A slight pearlitic ring can be present within a decarbonized border without a picture-frame fracture being produced. It is his belief that whether there will be a pearlitic ring or not depends upon the rate of surface decarbonization, as compared with

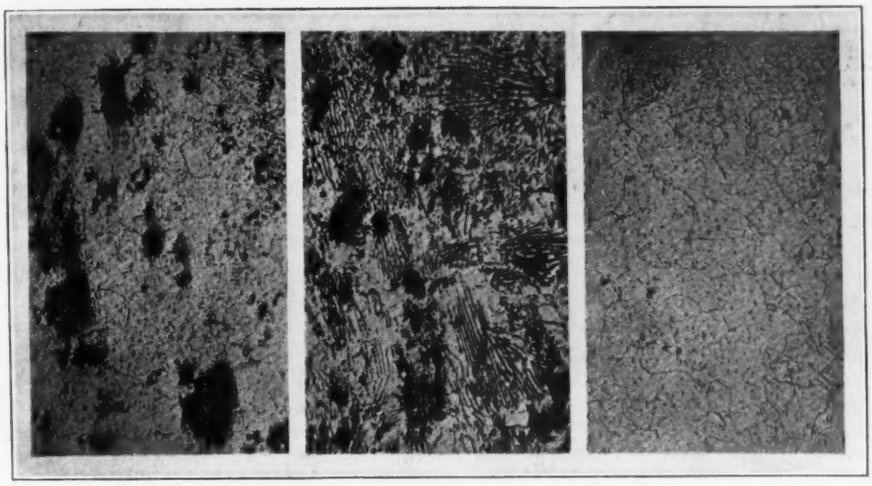


FIG. 2—DECARBONIZED BORDER. FIG. 3—PEARLITE RING. FIG. 4—CORE WITHIN PEARLITE RING

the rate at which a dissociation of the cementite takes place. When conditions are such that there will exist a region between the decarbonized surface border and the core that will have a carbon content of about 0.90 per cent, equilibrium seems to be established in this region, and if any carbon passes from this region to the decarbonized border it is replenished by carbon from the core.

The Pearlitic Ring

The writer believes that such is the case, and is of the opinion that perhaps the samples shown in Fig. 6 may substantiate this statement. A well-annealed bar was cut into eight pieces. A section from the first piece was polished and etched, and the other pieces were all packed together and given another anneal. The second specimen was then prepared like the first. The remaining six were given a third anneal, and the third piece polished. As this procedure was continued, it follows that the eighth bar had eight separate and complete anneals. It will be noted that this very faint pearlitic ring which shows whitish and very faint in the once-annealed bar, is very distinct and well defined in the second and that it is wider and further in toward the center. It will be seen that with each anneal the pearlitic ring has widened and has a smaller periphery.

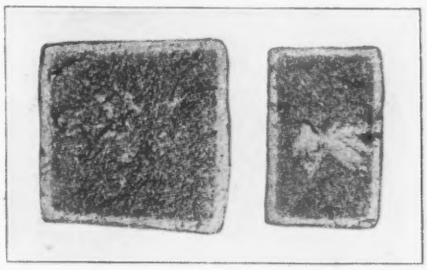


FIG. 5—PICTURE-FRAME FRACTURE IN HIGH-MANGANESE IRON, NOT BALANCED BY SULPHUR

As it was found that with each anneal the total carbon content decreased, it is plain that once the pearlitic ring has formed, it does not act as a seal for the passage of carbon from core to surface and that the width of the pearlitic ring is built up and added to more quickly from the core than it is robbed of carbon by the decarbonized border. The matter can be summed up as follows: If conditions are such that a region containing about 0.90 per cent or less of carbon is formed, this region while permitting carbon to migrate or diffuse through it will at the same time be incapable of having its carbon precipitated. Under proper conditions the region can alter its position and increase in extent. For such a region to have a start it is essential that there be a substantial difference in carbon content in two parts of the section.

Modern French Foundry in the Suburbs of Paris

(*Concluded from page* 434)

Co., Akron, O. The cleaning department is equipped with grinding wheels, brush wheels and tumbling barrels of standard construction. The molds are shaken out and the floors cleaned up by a night gang, the molders being employed exclusively on work which is directly productive of castings. Most of the workmen are paid on the piecework basis. Careful cost records are kept and the plant management is generally in harmony with the most modern policies.

Will Install Fittings Plant

The Bethlehem Steel corporation has completed plans for a standard fitting plant at Redington, Pa. This plant will be used for the manufacture of valves and other fittings of a like nature. It is planned to use one of the Bethlehem Steel Co.'s buildings at Redington which was used during the war in the company's fuse and shell loading operations.

The Sullivan Machinery Co., Chicago, has opened a branch office at room 810 Park building, Cleveland, under the management of Ralph T. Stone, who for several years has been sales engineer in the New York office of the company.

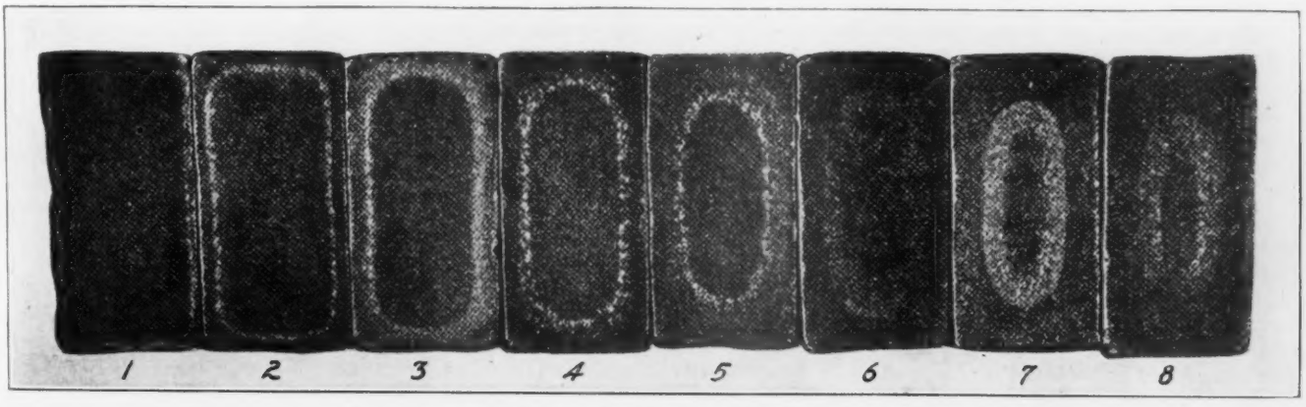


FIG. 6—PEARLITE RING AS IT APPEARED AFTER SUCCESSIVE ANNEALS

Metallography Applied to Nonferrous Metals—VII

Deoxidation of Metals and Alloys by the Use of Elements Having a Strong Affinity for Oxygen is Aided by Microscopic Study

By Ernest J Davis

IN concluding this general series of articles on the microscopic study applied to the nonferrous foundry, a few words on the important subject of deoxidation would not be out of place especially as the microscope is an excellent detector of such faults. Some difficulty frequently is met in the melting metals to form alloys especially copper nickel and nickel silver, due to the metals becoming oxidized. A knowledge of the causes and control of oxidation frequently determines whether success or failure is met in the foundry. It is well known that some metals when melted are capable of producing, absorbing, dissolving or alloying with considerable quantities of their oxides with detrimental results. This reaction of metals with their oxides is of more common occurrence than generally is supposed. The influence of oxide on a molten metal may be demonstrated by melting a small quantity of pure copper in a crucible without taking any precautions to prevent oxidation. The metal will be moderately fluid, but if a small quantity of phosphor-copper or other deoxidizer be added to the molten metal the increase in the fluidity is marked. For some time this increase in the fluidity of a metal has not been understood in its practical applications, and when aluminum was first introduced as a deoxidizer for steel it was commonly stated that the effect of the added metal was to lower the melting point of the steel. Measurements, however, produced proof that this was not true, but an increase in the fluidity was produced due to the removal of oxides. This was made more apparent by the heat produced in the combination of oxygen with aluminum. If a sample of the metal be taken before the deoxidizer is added and examined when cold, it will be found honeycombed and spongy. If a microsection be prepared and examined unetched, the oxide will be seen accompanied by numerous holes. In the case of copper, the cuprous oxide is soluble in the molten metal but separates out in freezing, and forms a eutectic containing 3.5 per cent of copper oxide or 0.39 per cent of oxygen. If there is less oxygen than 0.39 per cent primary crystals of copper are embedded in the eutectic and if more than 0.39 per cent of oxygen is present the eutectic surrounds primary crystals of cuprous oxide. The best way to examine copper for included oxide is to examine unetched, when the oxide particles appear light blue under white light and contrast strongly with the red background of copper.

Copper absorbs oxygen readily when melted, but when other elements are alloyed with it the copper oxide is always reduced and the added element is oxidized. Tin is commonly employed as an alloy metal with copper being used in all bronzes, and its oxide takes the form of angular crystals or needles of a dark bluish gray color, plainly visible in the section.

The influence of arsenic on oxidized copper is important. Additions of small quantities to the copper produce a marked change. The continuity of the eutectic is broken up by the *balling* up of a portion of the cuprous oxide. This balling up process gives a distinct improvement in the mechanical properties of the copper. As little as 0.078 per cent arsenic starts this balling up, and with 2.28 per cent of arsenic the whole of the eutectic is balled and arsenide of copper is formed. Fig. 1, is a micrograph of oxidized copper magnified 100 times taken from an actual failure. The addition of a deoxidizer results in complete removal of the eutectic and a homogeneous solid solution remains.

In order to prevent oxidation and absorption of gas as far as possible the metals are melted in a graphite crucible and usually are covered with a layer of charcoal, resin or other carbonacious material. In some cases borax is used as a covering as it easily melts and forms a protecting layer while at the same time it combines with any metallic oxides present and helps to keep the molten metal or alloy clean. The alloy may be stirred with a clean carbon rod or in some cases a green pole, the gases evolved from the wood serving to reduce any oxides present. Regardless of these precautions, however, oxides frequently are formed which are not reduced by carbon and

FIG. 1—OXIDIZED COPPER MAGNIFIED 100 DIAMETERS

FIG. 2—PHOSPHOR-COPPER CONTAINING 10 PER CENT PHOSPHORUS

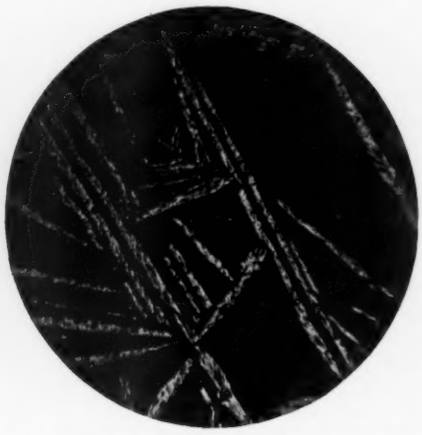


FIG. 3—PHOSPHOR-TIN COMPOUND MAGNIFIED 40 DIAMETERS

gases are absorbed. These gases are again evolved on solidification causing sponginess, and the difficulty then presents itself of deoxidizing the metal or alloy. In order effectually to free a molten metal or alloy from oxide it is necessary that the deoxidizer shall have a stronger affinity for oxygen than the metal to be deoxidized, and that any excess of the deoxidizer over that necessary completely to remove the oxide shall have no injurious effect upon the metal or alloy itself.

Deoxidizers Numerous

A large number of deoxidizers are now manufactured. Probably one of the most generally used deoxidizers especially for copper alloys is phosphorus in the form of phosphor-copper. Phosphorus readily combines with copper, the equilibrium diagram of the phosphorus-copper alloys has been determined up to 15 per cent of phosphorus above which amount the volatility of this element prevents further observations. The alloy can only be prepared in a closed vessel. There is a compound formed Cu_3P containing about 14 per cent of phosphorus by weight, which melts at about 1020 degrees Cent. and forms with copper an eutectic containing about 8.2 per cent of phosphorus melting at 707 degrees Cent. The compound separates in a pure state from the liquid alloys, but it is slightly dissolved by copper the maximum concentration of the solution being 0.175 per cent of phosphorus. The microstructure of alloys containing less than 8.2 per cent of phosphorus consists of primary crystals of nearly pure copper in a matrix of the eutectic in alloys containing between 8.2 per cent and 14 per cent of phosphorus. The primary crystals are of Cu_3P and the microscope reveals a structure as shown in Fig. 2, which is a phosphor-copper containing about 10 per cent of phosphorus. The eutectic has a well defined laminated structure and the compound Cu_3P is hard and brittle.

There are three brands of phosphor-copper made, one containing 5 per cent, another 10 per cent and a third 15 per cent of phosphorus. In the case of melting copper for electrical purposes the addition of a little phosphor-copper readily removes the oxides, etc., but any slight excess of the metalloid remaining in the copper would seriously affect its conductivity and its mechanical properties. For this reason a more satisfactory deoxidizer for copper has been sought and it is believed to have been found in *boronized-copper*.

Besides pure copper, alloys such as those of copper and tin or copper and zinc readily oxidize on melting and the oxides thus formed can be detected both microscopically and analytically. There is some difficulty in detecting zinc oxide in brass, but according to some authorities zinc oxide may be distinguished from tin oxide by its lighter color, smoother surface without dark outlines and more rounded form.

Alumina, the oxide of aluminum has exactly the same appearance in bronze as in steel. The dark color, small size, close grouping yet lack of coalescence, irregular shape and rough edges due to pitting are characteristic of alumina in bronze or brass. Phosphorus is an excellent deoxidizer for most copper alloys and may be added to the molten alloy as phosphor-copper or phosphor-tin, the choice depending on whether a large amount of phosphorus is required to remain in the alloy or whether tin is added. Fig. 3, is a micrograph of a phosphor-tin at a magnification of 40 and shows bars of a phosphor-tin compound in a background of pure tin.

In addition to phosphorus, manganese may be used as a deoxidizing agent in copper alloys and although it is a less active reducing agent than phosphorus it is of considerable advantage in that an excess of manganese does not render the alloys hard and brittle. Manganese is used commercially in the form of a 30 per cent cupro-manganese. It does not form any definite compounds with copper, the copper-manganese constitutional diagram being that of an unbroken series of solid solutions, although it much resembles a eutectiferous system. The presence of small quantities of manganese in alloys of copper with zinc or tin, therefore, does not as a rule give rise to the formation of any new constituents; the manganese enters into solid solution, and merely adds to the hardening effect of the dissolved metals.

A more powerful deoxidizing agent than manganese is furnished by aluminum. The oxides, however, differ in two vitally important respects. In the first place alumina, the oxide of aluminum, is an extremely refractory substance which has a strong tendency to remain in the molten metal in suspension as fine particles. These, of course, tend to lessen the strength and toughness of the alloy. Beyond this aluminum exerts a powerful hardening effect on copper, owing to the fact that it enters into chemical combination with that metal. Both these reasons are against the use of aluminum as a deoxidizer for copper alloys, although it is used to free steel from gases.

Deoxdizers should only be used to free the metal or alloy from the unavoidable oxidation which takes place even during the most careful melting and should never be regarded as an infallible remedy for careless melting. The knowledge that oxidation can be partially or wholly cured should not hinder the strictest precautions to prevent oxidation during melting. Excessive oxidation caused by too rapid melting and consequent overheating of the metal, or by overcharging the crucible, is often incompletely remedied by the addition of deoxidizers. The accompanying table is taken from Law's alloys, the ferrous alloys are included for completeness.

Deoxidizers Recommended for Various Metals and Alloys

Alloy	Deoxidizer	Form used
Iron alloys	Manganese	Ferro manganese or spiegeleisen
Iron alloys	Silicon	Ferrosilicon
Iron alloys	Calcium	Ferro-calcium-silicide
Iron alloys	Aluminum	Aluminum and ferroaluminum
Iron alloys	Titanium	Ferrotitanium
Iron alloys	Vanadium	Ferrovanadium
Bronze	Phosphorus	Phosphor-copper; phosphor-tin
Bronze	Aluminum	Aluminum
Bronze	Silicon	Cupro-silicon
Bronze	Manganese	Cupro-manganese
Nickel-silver	Magnesium	Magnesium or cupro-magnesium
Nickel-silver	Calcium	Calcium-aluminum alloy
Aluminum alloys	Magnesium	Magnesium
Aluminum alloys	Phosphorus	Phosphor-tin
Silver-copper	Cadmium	Cadmium
Cupro-nickel	Magnesium	Magnesium

Points on Mixing Iron

Question:—We would like to get some information as to the most economical cupola charge for our foundry. Our pig iron contains 2.40 per cent silicon and costs $28.40 per ton. We also have stove-plate scrap costing $10 per net ton and machinery scrap at $19 per net ton. Will you please advise the way to use these irons in order to get the cheapest mixture that will make metal satisfactory for machinery castings.

Answer:—It is rather difficult to obtain the cheapest mixture for your iron unless you have close metallurgical con-

trol. You should have in your finished castings an iron containing between 1.90 and 2.10 per cent silicon with reasonably low sulphur, say not higher than 0.120 per cent. The amount of silicon in the scrap would determine the amount of scrap you could use with your pig iron and unless you have analyses made of the metal from the cupola it will be necessary to figure the silicon in your mixture somewhat higher than you want in order to take care of any variation. It would be possible to use a mixture consisting of your home scrap with the remainder made up of machinery scrap and enough ferrosilicon—that with about 10 or 15 per cent silicon would answer very well—to bring the silicon in the castings up to 2 per cent. Then in the ladle three or four pounds of 80 per cent pea-size ferromanganese should be added in the ladle. After you become familiar with melting and casting this metal small amounts of machinery scrap can gradually be replaced with stove-plate scrap until the point is reached where no more stove-plate scrap can be added without causing trouble.

Such a mixture would require an analysis of castings from each heat and careful watching during melting, with the use of limestone and possibly a small amount of fluorspar to flux it. We would therefore recommend that you start to replace pig iron in your mix with machinery scrap and ferrosilicon a little at a time, and feel your way as you go until the ideal conditions are approached.

Making Manganese Bronze From Scrap Metals

By Charles Vickers

A PAPER treating of the utilization of scrap metals in making manganese bronze, presented by P. E. McKinney, at the New York meeting of the American Institute of Mining and Metallurgical Engineers, created much discussion as this practice is not extensively followed. In a written discussion Jesse L. Jones, Westinghouse Electric & Mfg. Co., Pittsburgh, states that a good quality of manganese bronze should contain not over 0.03 per cent of lead, otherwise it will not withstand the impact test and as a result will be unsuited for high grade engineering work. The lead, he claims, forms small pools in the alloy which act like breaks in the metal to form weak spots. High lead also produces an income of dross. High grade manganese bronze should also be low in manganese; the content of this element should not exceed 0.05 per cent, and some of the best grades show no manganese on analysis. Aluminum also should be present in only small amounts, 0.10 per cent being ample; otherwise the shrinkage of the alloy is greatly increased, and the alloy loses its distinctive golden color when taken from the sand. Mr. Jones holds that manganese bronze from scrap metals has a field as a second class quality alloy.

Some interesting manganese bronze history was presented by G. H. Clamer, Ajax Metal Co., Philadelphia. Mr. Clamer stated that manganese bronze was introduced into America 25 or 30 years ago by the Wm. Cramp Ship & Engine Building Co. That it is an alloy which it is considered demands the best materials. Lake copper was always used and usually the best grade of spelter. The Cowles Co., Lockport, N. Y., later commenced the manufacture of manganese bronze and produced excellent alloys having as high as 4 per cent manganese, and as much as 1.25 per cent aluminum.

As the number of manufacturers of manganese bronze increased cheaper methods were sought. This resulted in the use of cheaper grades of spelter, and about 10 years ago Mr. Clamer's company began to use zinc dross as a ready means of introducing iron into the alloy. This was found necessary as long as zinc low in lead could be obtained, but as this was not always possible the use of zinc dross was discontinued. On account of the fact that Mr. McKinney uses reverberatory furnaces which make the control of oxidation difficult, Mr. Clamer believes there would be some risk in using such metal for large and important castings. As the government specifications for manganese bronze are rigid concerning the use of scrap and the content of lead, he holds the paper significant, coming from a representative of one of the government departments. The navy department should be willing to modify the specifications, if they were accepting material of that kind from the navy yard.

C. R. Spare, American Manganese Bronze Co., Philadelphia, Pa., believes this method of using scrap of known composition is satisfactory in the case of the navy yard because there is a large amount of such material available, but it would not do for the average small foundryman to purchase scrap metals of unknown composition, with the expectation of getting dependable results. In his own practice high percentages of manganese have not been found to result in a weakened alloy. Manganese up to 5 per cent has been used. Castings to carry an air pressure of 3 pounds per inch contain high manganese, therefore, he differs with the statement that high manganese is not consistent with sound castings.

Mr. McKinney in reply stated that castings have been made up to 9½ tons weight by this method, and that they have been subjected to hard service during the war in torpedo practice. The objections to manganese and aluminum as ingredients may depend on whether new or scrap metals are used, but commercial grades of manganese bronze contain considerable amounts of both these metals. In his experience it has been shown that for a casting alloy, aluminum and manganese are beneficial in giving toughness and strength, without necessitating an increase of zinc.

From the preceding discussion, it may be noted there are differing opinions on the methods of making high grade manganese bronze. Some believe in low manganese and low aluminum; others in high manganese and high aluminum. Some think the alloy is not dependable unless made in crucibles. Others hold that none but the purest metals should be used in its composition. It is difficult to see how an alloy containing only hundredths parts of manganese, or none at all could be termed a manganese bronze. Only those with 2 to 4 per cent manganese should have claim to be so regarded.

Again it has been found by some experimenters that a "manganese bronze" with under 0.10 per cent aluminum and very low manganese must also have a low percentage of lead, otherwise it will be practically a yellow brass. Increase of aluminum means greater tolerance for lead. Therefore, if a zinc containing high lead is used, it will be advisable to also add over 0.5 per cent aluminum.

High lead and high aluminum cause greater drossing. This can be determined easily by adding 4 per cent lead to a 10 per cent aluminum bronze and attempting to cast the alloy in sand molds. It cannot be done. The alloy is not weak; on the contrary it is strong and fine grained. This shows how the aluminum offsets the weakening influence of lead. During the war period much manganese bronze was made using zinc of both high lead and high cadmium content, melted in oil-fired reverberatory furnaces.

Producing Sound Nonferrous Castings for Valves

Subjected to High Pressures, These Parts Must be Made to Withstand the Severe Treatment for Which They Are Designed—Good Foundry Practice for This Work is Described

By R R Clarke

TWO valve bodies are poured from the same pot of metal. The one leaks when subjected to the hydrostatic test and the other does not. How do you account for it? Can it be naturally accounted for? Assuredly so. The same laws operated in both instances. Have you ever thought of how fine the line must be between producing and failing practice in critical cases? A stroke of the rammer, an ounce of pressure, a volume of metal, a drop of water, a grain of compound, a degree of temperature, a trace of impurity, a hundred and one things above or below a critical point may be the contributing causes, and that which was meant to be good becomes utterly bad.

We might illustrate: A bushing pattern, 8 inches long, 6 inches outside and 4 inches inside is molded on end with a green sand core and is gated on top. Six molds are poured. Four of the castings are clean and have a smooth surface all over. Two are dirty on top and very rough on the core surface opposite the gate. The dropping metal found something wrong on the core sand surface and left its wicked scars. A critical point in the condition of the sand had been passed and ruin followed. The sand might have been just a trifle too wet and scabbed, too dry and washed, too hard-rammed, or poorly vented. Not very much perhaps, just a trifle, which was plenty.

Aspiring to Perfection

Recently we have been wondering what the possibilities of an alloy might be under perfect conditions of mixing, melting and molding. Some castings molded from the same pattern, by the same molder and poured from the same pot of metal, all at the same time, are by far better than others of the same lot, better not only in appearance, but in all the finer details of grain, physical properties, etc. Therefore, we know that practice unintentionally and perhaps unconsciously varies toward and away from ideal conditions. But we don't know how close it came to those conditions, nor what surprising results might follow if it had. About all we know is that it came close enough to pass inspection or to meet some specified test. The average foundryman may not appreciate this argument. The average foundry has no measured test to meet. On appearance its castings are accepted and by the same test pass on to service. Appearance is no criterion of how good or how bad the castings are.

To determine the approximate status of their practice as well as the merit

FIG. 1—THIS 2-INCH VALVE WAS SUBJECTED TO 3500 POUNDS HYDRAULIC PRESSURE, BUT GAVE NO EVIDENCE OF LEAKAGE OR BREAKAGE

of their product, the Eagle Brass Foundry Co., Seattle, chose a valve body to undergo a hydrostatic test either to the leaking or the breaking point. This valve was not specially made for the occasion, but was taken from stock. It was of the 1¼-inch, low-pressure (150-pound), angle type with walls ¼-inch thick and was made from an alloy developed in this shop. It was tested at the Skinner and Eddy shipbuilding plant and withstood, without leak or break, 1700 pounds pressure. Between 1700 and 1800 pounds the flange packing gave way and for the time being this ended the test. The valve was then taken back to the Eagle Brass machine shop for repacking and reinforcing the blank end plates. These plates were circular brass disks, 1 inch thick and were bolted to the valve flange with ⅝-inch bolts, four bolts being used on each end plate. For the second trial a higher grade packing was used and eight instead of four bolts were used. Again tested at the same plant the maximum pressure of the testing machine (2000 pounds) failed to register any weakness in the valve. A higher powered machine was then employed and the valve was subjected to 3000 pounds pressure without developing a flaw. The pressure was then rapidly advanced to 3500 pounds when the packing again failed to hold thereby ending the test with the ultimate strength of the valve undetermined.

Ultimate Resistance Unknown

Further means of preventing the end weakness were under consideration, when upon removing one of the plates it was found that under the enormous pressure, the valve flange would spring just enough to permit the water to get around the packing and escape. The resistance of the valve to water pressure, therefore is unknown, the only fact established being that the elasticity of the flange is somewhere between 3300 and 3500 pounds pressure. When it is remembered that the points of support in the flange, *i. e.*, the points of bolt position were far removed from the area of pressure application, it is at once plain that even this 3500 pound pressure was not a measure of metal resistance. The company making these valves concedes that not all its 1¼-inch low pressure globe or angle valves will measure up to that standard and yet it tries to make them all the same. Then why should any fail to pass the hydrostatic test? Precisely the same pattern and the same alloy was used as in others of the same denomination that held. Then why the difference? A line, a fine line marking an extreme limit of transgression in some correlated phase of practice is the cause.

In the founding of any casting you don't have to ball up everything, to get a bad job. One little thing is sufficient. The best mold that was ever made is no good if ruined metal is poured into it. Casting creation has its distinct phases of correlating effort. The manufacture of pressure valves represents a critical field of foundry practice. These castings have

to meet a test either before entering service, or by service which is sure to expose any weakness. Perhaps the most frequent trouble is leakage under pressure, either between mechanically-fitted parts, such as the valve seat, or through the solid metal of some part of the valve body.

Before considering the source and remedy for this evil, it might be well to inquire into those conditions of metal under which it will occur. The first of these is porosity which can be either natural or mechanical. Natural porosity is that degree of openness which all matter possesses and is listed among its general properties. In valve metal you want strength, density, toughness, resistance to corrosion and fair wearing quality. First you want a good noncorrosive base, that's copper. Next you want strength and more rigidity, that's tin. Following must be toughness and cleanliness, that's zinc. Finally you want density.

Copper, tin and zinc will give a fair density, but not often that which is required for valves. There is an element which is among the most dense of metals. That element is lead and it will accomplish mechanically what it could never do chemically toward closing up the natural porosity of the copper-tin-zinc combination.

Lead will greatly improve the machining qualities of the same alloy. But its content will bear judicious watching. Its primary effect on property is to break up the toughness of the metal and modify its strength and hardness. Machine cuttings from the copper-tin-zinc alloy are long drawn and spiral-like, indicating its tenacity and resistance. Those of the same alloy plus lead are short-broken and crisp, showing a suppression of these properties. Any high grade valve metal therefore will include the four constituents judiciously proportioned. Taking the well-known 85, 5, 5 and 5 combination as representative, we find that in low pressure and even in medium pressure (125 to 200 pounds) it will safely qualify. Beyond that, however, its strength is taxed and a high-powered alloy must be considered. This alloy is an advance of copper and tin at the expense of lead. A representative example will be found in what is known as *M* or Government valve metal which qualifies up to the 4-inch valve size and reads: Copper, 87; tin, 7; zinc, 5 and lead, 1. We do not believe this can be taken as an arbitrary ruling on the most efficient proportions of the formulating elements, nor are we convinced of its superiority over other alloys. Other valve metals which are in use for various fluid control purposes are the following:

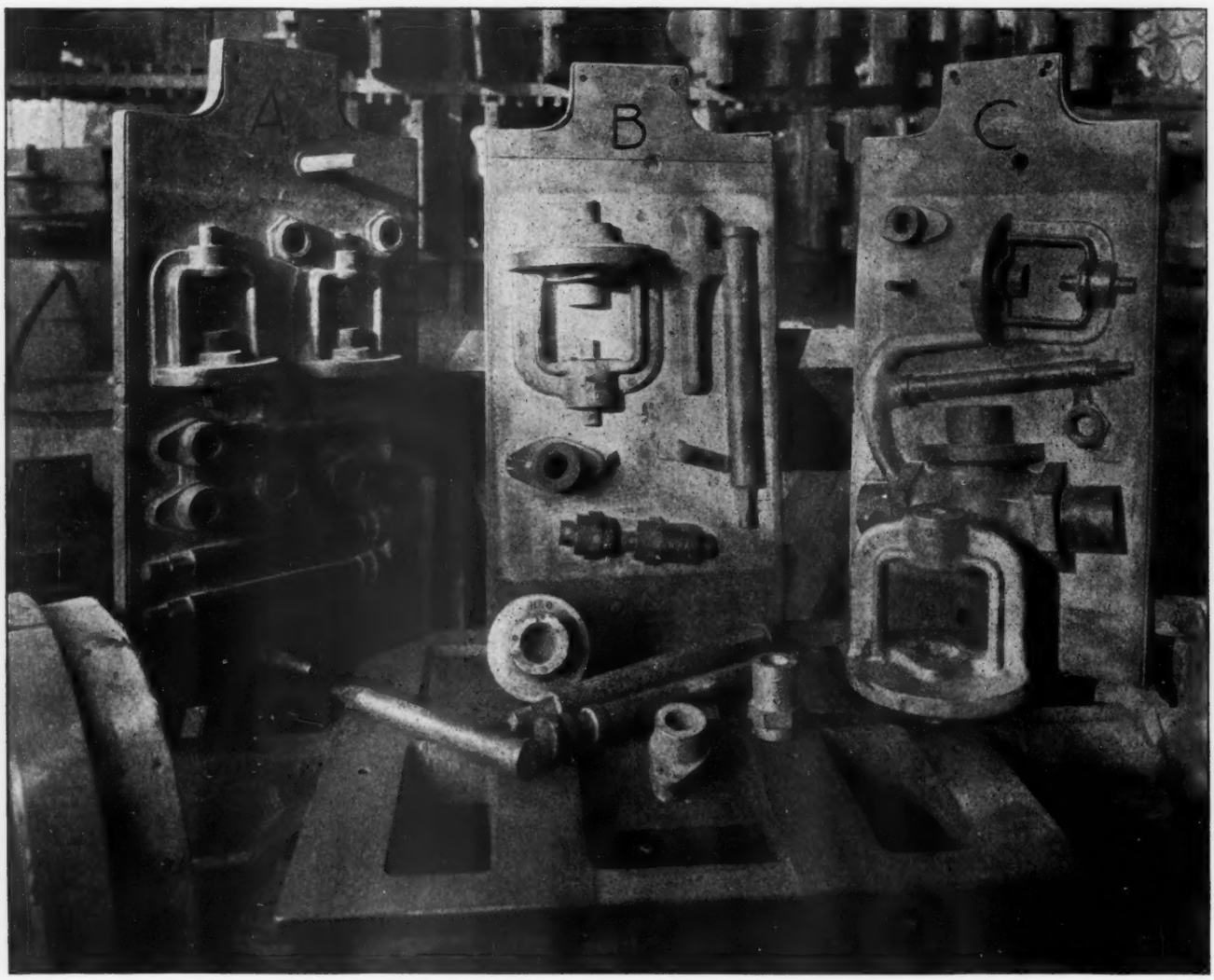


FIG. 2—AN ASSORTMENT OF PLATES FOR MOLDING VALVE PARTS

Copper, per cent	Tin, per cent	Lead, per cent	Zinc, per cent
88	10	...	2
87	8	...	5
86	3½	3½	7
87	6	1	6
86	6	2	6
87½	7½	½	5
83	7	3	7

Mechanical porosity is not necessarily inherent to metal, but is superinduced in it by external influences. It is an effect of some exterior cause and represents that type of porosity from which the vast majority of castings fail. Among its producing influences four are primarily culpable:

Bad mixing, bad melting, bad molding and bad pouring. Mixing is important and our practice is never to fall below a 60 per cent virgin metal constituency and to guard most faithfully against all contamination in the scrap. We want to know exactly what our valve metal contains. Of virgin metal we use good grades, but not metal from ferrous contamination. However, it was pigged and used for other purposes.

In addition, the vast surface exposed to oxidation by copper wire and the general run of copper scrap, decrees it good policy to use this grade of material in less particular work. When you get a valve metal combination your instructions and carrying them out faithfully. Next you need good furnaces, reliable auxiliary equipment and the best grades of fuel. We believe in rapid melting and metal distribution. Naturally our faith in molds ready ahead of the metal is pronounced and sincere. Finally, you must have clean furnaces and pouring

FIG. 3—LARGE VALVE BODIES MOUNTED ON PLATES FOR MACHINE MOLDING

the very best, that is not lake copper, Straits tin, etc. For the past couple of months we have used Tacoma copper and scrap trolley wire, prime western and brass special zinc, lead pipe and ordinary tin and have experienced no trouble. Special care is taken with the trolley wire which sometimes contains leaded sections. These parts are always thoroughly cleaned before being used. Resort to the general run of scrap copper is not considered because its qualities in general are seldom known. Scrap copper wire, for instance, can give you trouble unless you know it positively to be all copper wire. We spoiled one heat by being fooled on a very small bundle of copper-clad wire. The detection was made too late to save the that does the work, the thing to do is to stick to that combination. Such is our practice. It doesn't take much more or less of some constituents to change physical property, and besides you want your valves and all parts to show up exactly the same in color, in machine cutting, in fracture, etc. Nothing looks worse than the machined part of a pale valve yoke and a golden valve flange matched against each other.

By melting we understand the reduction and combination of the metals and raising them to proper casting temperatures. The first essential is a good furnaceman, one who knows the game and can appreciate the importance of its many small details as well as one intelligently comprehending ladles free from slag and contaminating crusts of metal left from previous heats of different composition.

As relating to porosity, the primary evils of bad melting are metal oxidation and the inclusion of gases. The consequence of oxidation is an oxide which is little more than a metal scale or dross distributed throughout the casting as a foreign substance. Occupying space that ought to be good strong metal and possessing neither strength nor stability of position it readily yields under hydrostatic pressure and permits the dreaded leak. By inclusion is meant those gases absorbed by metal in melting and liberated in cooling. The act of liberating occurs as the metal approaches its plastic state and re-

sults in a most aggravated state of porosity. Fortunately, oxidation and gas inclusion in great measure arise from a common cause and respond to a common remedy.

In this connection a detailed account of our own methods will suffice. The melting is done exclusively in air and oil furnaces of 1000 pounds capacity. Heats average 600 pounds. Furnaces are kept scrupulously clean and brought to a high temperature before charging with metal. Before each heat the furnaces are thoroughly slagged out by turning so as to throw the spout almost perpendicularly down and keeping the blast on full for from 5 to 10 minutes. In charging, the copper is first put in. If trolley wire is used, it is thrown in with the blast reduced and as the wire softens, it is poked down into a compact mass to escape undue oxidation. A good shovelful of lumpy charcoal is then thrown in, the furnace is closed and the copper reduced, but not superheated. The furnace is then opened, the bath skimmed off and tin, lead and zinc, in order, are introduced and thoroughly stirred. Following this, a shovelful of fine charcoal is scattered over the bath and the furnace is again started. Ladles are then preheated and preparations for pouring the molds are begun. In drawing metal from furnace to ladle, charcoal is always first thrown into the ladle before starting to fill it. This charcoal is skimmed off just before pouring and a fresh layer added.

A word about the use of charcoal might be worth repeating. Charcoal's greatest benefit to metal is in its combustion. It is this process that eliminates the developed and developing oxides on the metal surface. Charcoal burned to ashes has no chemical action on the metal and subserves no further purpose than a mere covering to exclude what atmosphere it can. When pouring metal, we always like to see the charcoal burning brightly and the clean, limpid metal underneath. The reduction of oxides and the elimination of gases are effected by reagents common to present-day practice. Zinc is one of these reagents

Pertinent Pointers for Valve Founders

A GOOD, strong valve metal should consist of normal copper, high tin, conservative zinc and low lead. As a deoxidizing and gas-eliminating agent insuring solid, compact valve metal, phosphorus merits a recognized value.

Zinc and phosphorus function in part to common ends in an alloy and presuppose a reduction of the one with an increase of the other.

Between zinc and phosphorus, phosphorus is the more powerful as a deoxidizer, but less assertive and not so desirable in effect on the physical property of valve metal.

Zinc toughens and phosphorus hardens metal. Toughness is a prime requisite of valves; hardness, though essential, is not so essential.

The volatilizing point of zinc is far below the superheated temperature of the average valve metal. Superheated metal, therefore, will have a reduced zinc content.

Lead favors density of metal and ease of machining. Its primary effects are to soften and reduce strength.

The sum total of pressure on a valve body varies with the inside area or surface. At the same unit of pressure, a 2-inch valve suffers less than a 4-inch. Naturally, the larger sizes of valves require the stronger metal.

Critical surfaces on valve parts should be cast in the drag half of the mold.

Primarily, valve bodies leak from molecular weakness, natural porosity, mechanical porosity, impaired metal, hair-line fracture and the interposition of foreign substances such as dross, oxide, mold dirt, etc.

A good, strong, well formulated alloy, with a fair amount of virgin metal will aid greatly toward overcoming molecular weakness and natural porosity.

Good furnace practice and correct pouring temperature are absolute conditions to unimpaired metal.

Reinforced sections of unions of parts of valve bodies and well rounded fillets operate against the hair-line fracture.

The use of scrap material involves judicious selection. Scrap copper, representing previously cast material, is open to question, it generally being unknown what practice prevailed or what alloying elements formed a part of the previous casting.

Sand in a badly mixed state or in too wet a condition is a fundamental menace to satisfactory results in making valves.

Proper gating ranks high among the particulars of practice in making valves.

Metal of all virgin constituency will shrink less and will show a finer grain when combined, pigged and remelted than if cast from the first melting.

Bringing superheated metal to a correct pouring temperature cannot be taken as an infallible cure to the superheating evil.

A trace of phosphorus, or a corrective quantity of zinc placed in a superheated bath is a strong argument to the elimination of gases and oxides.

The intelligent use of charcoal is among the greatest assets to clean, strong, pressure-resisting metal. If correctly and faithfully used, no other neutral flux need be considered.

Core mixtures and the condition of cores exercise a strong influence over the status of valve castings.

Flange attaching risers are not essential to solid castings. The vent wire, however, is a very promising tool in this connection.

Careful molding is a leading part of successful experience in making valves.

Pouring valve stems in vertical position gives excellent results. With the larger sizes of stems, horizontal pouring sometimes sponsors distress. No trouble should be experienced, however, up to and including the 3½-inch.

Strong gate pressure and live, hot metal in pouring favor compactness and all-around solidity of valve castings.

Cold metal invariably produces dangerous castings.

The top of a pouring gate should show deeply-drawn, downward shrinkage. Convexity of the gate top almost invariably can be taken as an ominous sign.

In using iron nails to anchor pockets in the different parts of valves and especially the valve disk, care should be exercised to prevent exposing the nail heads to the metal.

and phosphorus is another. Personally, we never advocate the use of each in the same mix. However, later experience to which air and oil melting has furnished many studies, has convinced us that where the zinc content is not too high (3 to 5 per cent) a mere trace of phosphorus added to the metal in the ladle just prior to pouring, and thoroughly stirred, will yield a decided benefit. Superheating metal is a primary incentive to oxidation and gas formation. When for any reason a ladle of metal comes from the furnace in a superheated state, unless phosphorus is resorted to, we stir into the metal in the ladle a small amount of additional zinc figuring that what is added will merely compensate that lost through volatilization. And we are thoroughly convinced that by this method we have more than once escaped both a gas and oxide porosity in the casting, and at the same time interfered but imperceptibly with its calculated composition.

In reducing the metal, the furnace flame is carefully watched to see that it is the least destructive to the metal quality. We would rather burn too much oil than not enough, although a happy medium is our aim.

Good valves presuppose the very best molding practice. All valve bodies and their parts up to and including the 3½-inch size are made on hand-squeezer molding machines operated by men taken from the ranks of labor and broken into the game less than nine months ago. The loss on these machines is all but negligible. A curious feature of their operation is that no matter what the size or depth of the pattern absolutely no hand ramming, but instead hand tucking is done. While it is appreciated that the plain squeezer is not the logical machine for this work, it was all that we had available. The logical method would be to employ a combination jolt-ramming and squeezer machine with stripping-plate attachment for this work.

Three of the four machines we have been operating for the past eight months were bought at scrap iron price from a foundry that had tried and discarded them, relegating them to the junk pile. There we found them, took them to our own foundry, fixed them up and decreed to them a better fate. In introducing the first two we instructed the operators to pien-ram around the flask edges. That went on for a month or so until we came to start the third machine when the cry of "too many machines" went up. On the mere and baseless technicality of piening around the flask edge, the shop committeemen informed us that we were usurping molder's rights. The time was critical. Labor conditions unknown in the east prevailed and we saw in discretion the better part of valor. We conceived the idea of hand-tucking before squeezing instead of hand-ramming with a molder's tool. One of the machines was making a heavy eccentric rod in a 14 x 32-inch snap flask. On that we tried the tucking stunt and were surprised at the result. Since then we have made thousands of castings of all shapes, weights and sizes on straight hand squeezers and have done absolutely nothing but tuck and squeeze. Castings made this way are of the very best type and production proceeds remarkably fast. And that's the way we

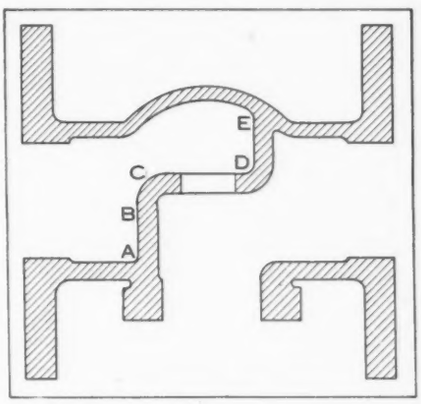


FIG. 4—CROSS-SECTION OF VALVE BODY

make valves up to and including the 3½-inch and would go still higher if our machine flasks would take larger sizes.

A view of the many pattern plates mounted during the past year is shown in Fig. 2. The plate *A* contains two parts each of all parts of a 2½-inch angle valve, adapted for a 12 x 16 inch flask. The plate *B* contains one part each of a 3½-inch valve and plate, *C* contains all of the parts for a larger valve. The methods of gating also are clearly illustrated. In the foreground are shown some of the castings molded from these plates. Additional plates for molding in 12 x 16-inch flasks are illustrated in Fig. 3. Plate *A* shows the cope side of a 3½-inch globe valve body. Long pins are employed in making the cope to guarantee an absolutely true lift in drawing the pattern. In drawing the drag pattern, the 3 inch flask pin serves as a guide and disengages the pinhole while the flasks of the pattern are still in the mold. Plate *B* contains a pattern which is difficult to draw by hand. The flanges are absolutely straight, bind at three points and remain in the mold 2½ inches after the pin disengages. Plate *C* contains a pattern on which the core print had to be sawed off to get it into a 12 x 16-inch flask. Nails extending to the bottom board of the drag and to the top of the cope are set over the short end of the core print to support the core and to keep it from raising. At *D* is illustrated an angle valve body made from a similar plate as that shown at *C*.

Primarily, the molding sources of porosity are wet sand, hard ramming, insufficient venting, illogical gating, and hard, strong cores. From wet sand, hard ramming and strong core mixes derives a metal agitation outlasting metal liquidity, preventing an uninterrupted, compact settling to a solid state. Inadequate venting effects the same result by offering inadequate escape to the gases. From bad gating comes insufficient pressure and improper feeding, resulting in the draw either from casting to gate or from one casting part to another. To the eye this drawing usually expresses itself in one or a few large cavities, but that is by no means all of it. Microscopic observation will often disclose a great number of very small cavities leading away from the larger and terminating in that part of the casting too far removed from the seat of disturbance to be affected by it. In making valves our machine molders understand that the sand must be absolutely right, a fair quota of new sand forming a part of the mixture which is well tempered and riddled before using. It can contain no lumps, wet and dry sections and the like. The flasks used are of the steel type, 12 x 16 inches in size. The sand is thrown into the flasks and is well tucked around those pattern parts requiring the greater hardness. The frame or upset is then added, filled and a second tucking given. Sand is then thrown on for squeezing and is distributed over the surface to properly vary, after squeezing, the hardness in different parts of the mold. The mold is then well vented, rolled over and the pattern plate drawn.

Copes and drags are made independent of each other. Some of the patterns are of such depth that they remain in the sand long after the pattern plates have disengaged the flask pins and holes, but so adept have the machine molders become that they make the free lift without a break. Very few nails or anchors are used in the molds. On the tops of the flanges, or for that matter anywhere, risers are never used, but instead fine vent wires are run through the sand from the inside. Strong gate pressure is invariably employed, the head of the pouring gate always extending from 4 to 7 inches above the highest casting point. Cores are made conservatively soft, well-vented and extra precautions are taken to keep the metal out of the vents. We want no

dancing of metal over cores in valve bodies. Flat boards are placed over the tops of the flasks and the molds are firmly and securely weighted down for pouring as soon after assembling as possible. We are opposed to leaving the cores in their molds too long before pouring.

Mounting the Pattern Plates

In mounting pattern plates for molding, wooden boards and wood patterns are used. The boards are iron-bound and soaked in oil two weeks or more before they are used. Every detail of practice is carefully considered in arranging the patterns. In the smaller sizes (up to the 2-inch) a complete valve, including body, stem, yoke, gland, nuts, etc., are mounted on one board. Above that size, however, the body is mounted singly on one board and the parts grouped on another, the group sometimes including two patterns of each part. The bodies and yokes are all gated on the flange, the stems at the heavy end, and the other parts as can best be arranged. Yoke, body and stem, we might add, are invariably placed as close to the sprue as possible. Following mounting, a trial mold is made and every detail of the castings is gone over thoroughly to make sure of no erratic condition in the arrangement or the gating. Regarding risers we might state that our best results have been without them. The tested valve casting previously referred to had nothing but a single ingress gate attached to the flange, built up to a height that would generate strong gate pressure of its own accord. What advantage risers attached to the flanges' highest points could have been in this particular case would indeed be hard to discern in the light of the valve's tested quality.

Another practice we have no faith in is the churning of the pouring gate in this class of work and with the average valve metal. If you run your pouring gate high enough you will get a strong, natural and undisturbed feeding of the casting which is the best that can be expected. After all and in the light of analysis, what can a direct riser accomplish in this type of casting? No additional pressure is derived from it and unless exceedingly bulky, its metal precedes that of the casting in cooling and is just as liable to rob the casting as to feed it. In this the weight of opinion as expressed in practice is probably against us, but the weight of evidence in solid castings is in our favor. Notice the top of almost any riser in this class of work and you will observe an almost imperceptible downward shrinkage in it. You don't find that in your pouring gate and if you do, you have good reason to mistrust your casting. The inference is that your pouring gate feeds, but your riser doesn't, so why waste metal on it? All this, of course, applies to this type of casting and alloy.

Everything is important in making valves, but nothing is more so than pouring temperature. That temperature imperatively is a high one. Dull metal, porosity and sponginess of casting go hand in hand. The power of a liquid to generate gate pressure, as well as its capacity to float and not include its dross, increases with its fluidity, which in turn advances with temperature. Valves poured hot are cleaner and more compact than those poured cold. But an extremely high temperature is also dangerous by virtue of the evils already discussed regarding superheating. Correct temperature, therefore, lies between two points, the one representing the metal's inability to function as a liquid, the other its very serious tendency to strike up correspondence with dangerous gases. In pouring we strive for that degree lying safely from the gas-absorbing state which means that we pour just as hot as we feel we safely can. Such a state of metal is more easily judged than described. Metal poured too hot gives a surface pitted and inner porous condition. That poured too cold produces drossy and spongy castings. As nearly as we can describe it, we take the phenomena of correctness to be yellow to white in color, a clear, limpid appearance under the oxide film on the metal surface and a decidedly low viscosity.

Hair-line Fracture Causes Weakness

Next to porosity, perhaps the hair-line fracture is the most prevalent cause of valve weakness. Analysis shows this evil to be one of the most natural in all casting creation. Deriving from the simple principle that expansion, contraction and metal congealation all vary with bulk, it suggests the vast significance of correctly designed and proportioned patterns. Wherever a light section joins a heavy section, or *vice versa*, in a non-ferrous casting, look out for a weakness if the casting is subjected to its enduring limit. The evil, its cause and remedy can best be studied from the cross-section of a valve in Fig. 4. Web *A B C D E* is heavier than the walls to which it is attached. One wall metal consequently cools first and draws from the web metal. The web metal congeals next and endeavors to reclaim from the wall metal. But the wall metal is solid and yields nothing. The web metal draws away leaving the open breach. And the same thing can happen between flange and wall and for identical reason. There is no such thing as give and take between sharp variables of bulk in a casting. In reducing the difficulty three things must be considered, reinforcing the wall at its points of union, rounded instead of square angles of union and hot metal in pouring. We believe that if these three items be given painstaking consideration, the hair-line fracture will disappear providing, of course, the molding and gating practice be otherwise good. Independent of the pattern construction, cold pouring, low gate pressure, wet sand, insufficient venting and hard ramming are chiefly conducive to the evil set forth.

Impaired Metal Causes Trouble

Next to porosity and the hair-line fracture, impaired metal is a source of trouble. This metal has not been completely ruined by practice, but decidedly weakened. We have always thought of it as partially oxidized metal much the same as scorched cloth is only partly burned cloth. This metal frequently will be observed to occur in spots, brown or rust-like in color and showing up plainly when the casting is cold broken. It bears the same relation to the unimpaired metal as the section of scorched cloth does to the garment. Occurring in the critical parts of a valve, its weakness becomes manifest and decrees the valve to failure. Its most likely origin is in surface metal unprotected which enters the mold with the pouring stream. Here we strike another important phase in the use of charcoal. In pouring the metal the charcoal should cover every possible unit of the metal surface lying as close to the pouring lip as its exclusion to the stream by careful skimming will permit.

Mainly, the parts making up a complete valve are the body, stem, disk, yoke, gland, stuffing box and the nuts used in connection with these parts. The body, stem and disk are the most important and call for clean, strong metal. All valve disks are cast in our shop with the face side down and all stems are molded and poured on the horizontal, being gated on the heavy end and subjected to strong gate pressure of clean, hot metal. A still further cause of valve trouble is the interposition of unalloyed foreign substances. The most likely of these to occur is iron by accidental contamination. Generally, the iron will occur in the casting either as a nodule or as a sort of a flake. Its origin may be traced to the use of scrap containing iron and to the use of the iron skimmer or stirring rod in metal approaching the iron fusing point. No valve metal containing un-

alloyed iron can ever be trusted.

Molds for valves ought to be absolutely clean and secure. Sometimes parts of the mold will cut or wash away by the action of the metal. In such cases dirt is always looked for on the highest point of the casting, but not always found. But that is no guarantee that damage has not been done. One thing is sure, the dirt is in the casting somewhere, perhaps in some critical part and by shipping that casting you run a fair chance of getting it back. Clean-cut, smooth, uniform-surface cores well blackened, are prime essentials to good valve bodies. Cores with fins, open sutures, and whiskers on them can sponsor lots of trouble more serious than the extra work entailed in cleaning them.

Summing up the situation we find that valves leak and go wrong generally from porosity, molecular weakness, fracture, impaired metal and interposition of foreign substances, that one and only one type of porosity and molecular weakness is inherent, namely, that predetermined by the composition of the metal and that all other porosity, weakness or shortcoming in the casting derives its origin absolutely from practice.

HOW AND WHY IN BRASS FOUNDING

By Charles Vickers

Aluminum Alloy For Automobile Engine Pistons

We are casting a number of automobile pistons of the following alloy: Copper, 2 to 3 per cent; nickel, 1 to 2 per cent; magnesium, 1 to 2 per cent, iron and silicon under, 1.5 per cent, and aluminum, balance. Will you kindly advise at what temperature this metal should be poured; also if that temperature is usually determined by the use of a pyrometer, or does the metal present certain characteristics which enable those who are experienced to judge near enough without a pyrometer. If the latter is true kindly advise just what these characteristics are.. Would you recommend the use of the same grade of sand as is used for small brass castings such as globe valve bodies. Also advise how long these castings should remain in the sand, after pouring, and what the effect of shaking out too soon, or leaving in the sand too long would be. Also any information in regard to the alloying of the above mixture would be appreciated, as well as information in regard to melting the same.

The temperature at which the alloy should be poured will depend entirely upon the wall thickness of the castings. The lowest possible casting temperature should be first determined by setting up several molds and pouring them under foundry conditions with metal that is progressively cooler for each mold. As a guide it may be stated that aluminum which shows red in ordinary light and a faint red in a bright light will be at a temperature of about 875 degrees Cent. Some castings will have to be poured at this temperature in order to run them, but no casting should be poured at this temperature if it can be just as well run at a lower temperature. The cooler the molten aluminum, and especially when it contains magnesium, the stronger and the more free from defects will be the castings. If a pyrometer is available it should be properly calibrated and then be used to take the temperature of the test heats. A temperature of 750 degrees Cent., or 1382 degrees Fahr., is about as low as thin walled castings can be poured and have them run. When the coolest casting temperature is determined pour each heat at this temperature. It would be advisable to control the temperature by pyrometer, because it is difficult for the eye to adjust itself to the different lights, and on a dull day the metal might be poured too cool to run, as it would look hotter. When the metal is poured hot, it will remain liquid within the mold for some time, and it will simmer gently if not extremely hot. This simmering abrades the mold walls and sand grains get into the casting. If quite hot the aluminum decomposes the moisture and absorbs the hydrogen which creates little holes in the castings that resemble black specks when the castings are machined.

The sand used for valves will be satisfactory. The castings should be shaken from the molds before they are cold, but they should not be hot and tender. Allow them to cool until the heads slowly evaporate water dropped upon them, otherwise, if allowed to cool the sand will stick to the castings, and often will discolor them. The alloy should be put together by the use of a hardener containing the copper and nickel, and the magnesium should be added last. If zinc chloride is used as a flux, add it after the metal is ready to pour. Add the flux in the furnace if crucibles are used, as this permits the fumes to go up the stack. Skim as quickly as possible after using the zinc chloride, and do not allow it to remain long in contact with the aluminum. In melting keep below blood-red heat.

Metal Thickness Insufficient for Pressure Applied

We are making valve castings to be used on heavy hydraulic presses, which are tested to a pressure of 4000 to 4500 pounds. These castings are cored out, some having 2-inch and others 4-inch cylinders. The valves are about 8 inches square and the average thickness of the metal is from ½ to ⅜-inch. We use half new metal and half gates from previous heats of the cylinder castings. We melt the metal in crucibles. Please advise us if there is any nonferrous metal that will withstand this pressure. The castings appear good and do not show any shrinkage, but the metal seems to be porous, or the high pressure forces the water through the metal.

The walls of the valves are too thin to withstand the pressures to which they are subjected. All metals are porous. For example, gold when rolled into sheets and formed into cylindrical shape will sweat when filled with water and compressed; also, when hydrostatic presses are in use under great pressure the water is frequently forced through the pores of the cast iron, even when the latter is of great thickness. The thicker the metal wall the greater the pressure required to force the water through the pores of the metal, considering only metal that is perfectly alloyed, and contains no oxides; therefore, the walls of the castings must be sufficiently thick so that the pressure required to force the water through them is greater than the pressure to be applied. A wall ¾-inch thick is required for the pressures mentioned, but if the castings can be chilled the grain of the metal will be closed and possibly a little less than ¾-inch thickness could be used.

An excellent hydraulic metal mixture follows: Copper, 90 per cent; tin, 6

per cent, and phosphor tin, 4 per cent.

A harder alloy consists of copper, 80 per cent; tin, 10 per cent; zinc, 5 per cent and lead, 5 per cent. Add the zinc in the form of yellow brass and melt the metals twice.

Melting Losses in Metals and Alloys

We should like to know the melting losses of the following metals: Copper, spelter, block tin, block lead, No. 12 aluminum. What is the percentage of loss in the alloy of copper 80 per cent, tin 10 per cent, lead 5 per cent and zinc 5 per cent. Also, what is the loss on copper 69 per cent, tin 2 per cent, lead 6 per cent, and zinc 23 per cent?

The average melting loss of all the metals and alloys named will vary with the plant melting them. The ideal losses should approximate the following: Copper, 1 per cent; bronze, 1.5 per cent; red metal, 1.5 per cent; yellow brass, 2 per cent; aluminum, 0.5 per cent. On such metals as pig lead and tin the loss should be under 0.5 per cent, and also on spelter the loss should be low because in running this metal alone, there is no reason for it to be heated to the point of volatilization. The gross losses of one concern on yellow brass were 16.50 per cent; on 88-10-12 they equaled 7.88 per cent; on copper, 85; tin, 5; lead, 5; zinc, 5 they equaled 9.12 per cent, and on aluminum, 6.24 per cent. About half the gross loss should be recovered from the skimmings.

Using Coke for Charcoal as a Cover

We have been impressed with the fact that practically all articles that treat the subject of melting nonferrous metals recommend the use of charcoal or ground charcoal. Now many foundries have fine coke or facilities for grinding waste coke that is too fine for use in their pit furnaces. In that both charcoal and coke are mostly carbon is there any reason why ground coke would not answer the same purpose of a cover—as ground charcoal? Does the fact that the coke is likely to contain sulphur and iron, and possibly more ash than charcoal, prohibit its use as an economical substitute for a charcoal cover?

Charcoal is used as a covering in melting nonferrous metals because it is low in sulphur. Sulphur is an element which it is always advisable to keep away from copper and its alloys, because it reacts with oxygen to form a gas, sulphur dioxide. This gas is soluble in the metal, both in the liquid and solid states. The reaction between sulphur and oxygen, therefore, is a fruitful source of the troubles experienced from porosity. Neither sulphur nor oxygen alone produce porous castings, but of the two evils, it is more easy to guard against sulphur than oxygen in melting. Therefore if the sulphur is guarded against, in the case of ordinary castings, a little oxygen is not noticeable. Sulphur weakens the metal, by introducing a nonmetallic element, while the oxygen combines with the metals and forms oxides. There is no reason why coke should not be used as a cover in place of charcoal, and if a flux of sand, lime and a little borax is also used, the ground coke will be gummed together and will make a cover that should exclude the air. If this can be done, a little sulphur will do no great harm.

Making Castings for Torches

We have tried to make brass castings for gasoline torches, but have not succeeded. We have experimented with a number of alloys. The difficulty is that the castings leak and will not hold the gasoline.

An alloy extensively used for parts of gasoline burners follows: Copper, 78.75 per cent; phosphor copper, 0.25 per cent; zinc, 15 per cent; tin, 3 per cent and lead, 3 per cent. Melt the copper under a cover of charcoal, 1 inch thick; add the phosphor copper, or place the phosphor copper in the bottom of the crucible and charge the copper on top and melt them together. When the copper is melted, add the zinc, then the tin, followed by the lead, stir thoroughly. Castings made from this alloy will not leak, but if a metal with a redder color is desired, the following alloy can be used: Copper, 85 per cent; tin, 7 per cent; zinc, 5 per cent and lead, 3 per cent.

Leakage may be caused by oxides dissolved in the metal, or aluminum may be present; therefore, careful attention to the selection of the scrap used and to the melting of the alloy will materially aid in overcoming this difficulty.

How to Solder Aluminum

Will you kindly give us the best method for soldering aluminum?

It is doubtful whether aluminum can be successfully soldered with common solder and therefore, it would be advisable to use a special aluminum solder, of which there are many on the market. If the solder is purchased, the manufacturer will furnish full directions for its proper use. If it is desired to make the solder, the following alloy is as good as any: Tin, 29 parts; zinc, 11 parts; aluminum, 1 part and 5 per cent phosphor tin, 1 part.

Stearic acid is often used as a flux. The soldering iron should be hotter than for ordinary soldering, and the article to be soldered should be heated and scraped clean, before the flux is applied. The soldering iron must be heavy to retain its heat. Melt the solder sufficiently fluid to flow, and rub the surface of the aluminum under the molten solder to dislodge oxides.

Introducing Iron in Alloys

We have a number of brass castings to make that must contain 1 per cent of iron, and we would like you to inform us if it would be advisable to use a zinc-iron alloy to introduce the iron, and if so where this alloy could be obtained.

It is not necessary to use a zinc-iron alloy to introduce such a small amount of iron as 1 per cent. We presume the alloy is a yellow brass containing iron, in which case all that is required is to melt the copper under charcoal, and when it is completely fluid add the 1 per cent of iron in the form of loosely coiled strips of clean tin plate. Simply drop the iron onto the charcoal covered surface of the copper and then quickly push it under with an iron bar and stir it thoroughly to incorporate the iron. The iron will deoxidize the copper, and thus add strength to the alloy. After the iron has been added, follow with the zinc, stirring thoroughly. If the metal can be ingoted and the ingots remelted for the castings, better results will be obtained as the alloy will be thoroughly mixed.

Preparing Bronze Bushings For Sale

Will you kindly advise us in regard to the most satisfactory method for preparing bronze bushings for sale, in order they may be uniform in color. There are two cleaning methods, a sand blast and a pickling process, and we desire to know which is the best.

In addition to the methods mentioned, there is the tumbling barrel; but the pickling process is seldom used as it is disagreeable and messy and the castings after being cleaned may turn green in storage. The tumbling barrel produces a satisfactory product provided a wood-lined barrel is used and the castings are so packed that the barrel is filled to the point where the castings are not battered. The barrel has to run a long time, and must have skimmings and fine ashes mixed with the castings. When this is done with care the result is a clean, fine appearing casting, and all the castings are made uniform. The sand blast also produces a presentable appearance, and this method is largely used in finishing bushings, while the tumbling barrel finds more favor in the plumbing goods industry. The sand blast is greatly to be preferred to the pickling process.

Pouring Metal Direct From Furnace to Molds

Electric Furnace Provided With Tilting Arrangement Which Keeps the Spout at the Same Point in All Positions

WHEN melting bronze and brass the question of high temperature is not a consideration, as it is in the case of steel. On the other hand, care must be taken not to get the metal too hot, of which there is danger in that form of electric furnace used for steel melting known as the direct-arc type, in which the arc goes straight from the electrode to the metal bath. In such a furnace the arc going to the metal would produce a temperature which would volatilize the alloys. The Rennerfelt furnace, a cross-section of which is shown in Fig. 1, surmounts this difficulty by arcing from one electrode to another instead of arcing from the electrode to the metal.

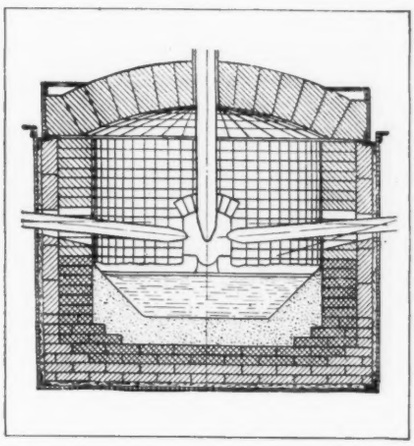
Even when the arc does not come in direct contact with the metal, the melting loss varies directly with the temperature it is necessary to attain. By pouring the alloy from the furnace into molds without any intermediary ladles, a less highly heated metal is required; also a considerable saving in labor is achieved through doing away with the necessity for transferring the metal from furnace to ladle.

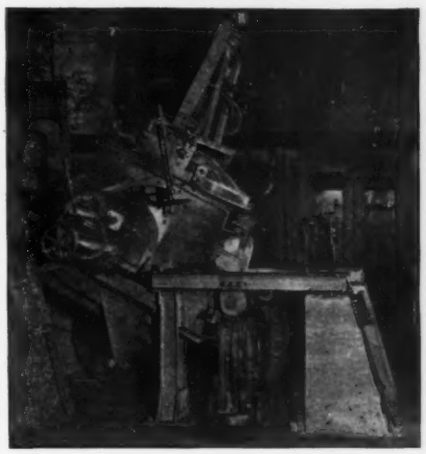
Hamilton & Hansell, Inc., New York, have designed a mounting for the Rennerfelt furnace by the use of which the spout of the furnace always delivers the stream of metal at the same point. This makes it possible to bring molds under the spout and pour the metal without spilling it.

A 1-ton Rennerfelt furnace equipped with this tilting mechanism is shown in Fig. 3. Two of these are installed in the United States mint, Philadelphia. A diagram of the tilting arrangement is illustrated in Fig. 2.

The length of the arc is automatically adjusted by a General Electric regulator. The furnace is tilted by an electric motor, geared down and connected to a drum by a worm gear. From this drum two parallel cables run over a pulley supported higher than the furnace on a concrete pier. By winding or unwinding the cable on the drum, the rear of the furnace is raised or lowered, while the front, which turns on a trunnion, remains at the same level no matter how high the back is raised, and the lip of the spout is always at the same point. The cables attached to the rear of the furnace raise it to the required height and also prevent it from rolling over.

The ingot molds into which the melted metal is to be poured are brought under the pouring spout on trucks, three molds being placed on each truck. The mold trucks are moved by an endless chain which is driven by a motor with push-button control. With this arrangement one man is able to regulate the tilting mechanism of the furnace and at the same time move the molds under the lip of the furnace as they are required. Previously five men were employed for the operations now requiring only one man. This was because the metal was poured from the furnace into ladles and carried to the molds.





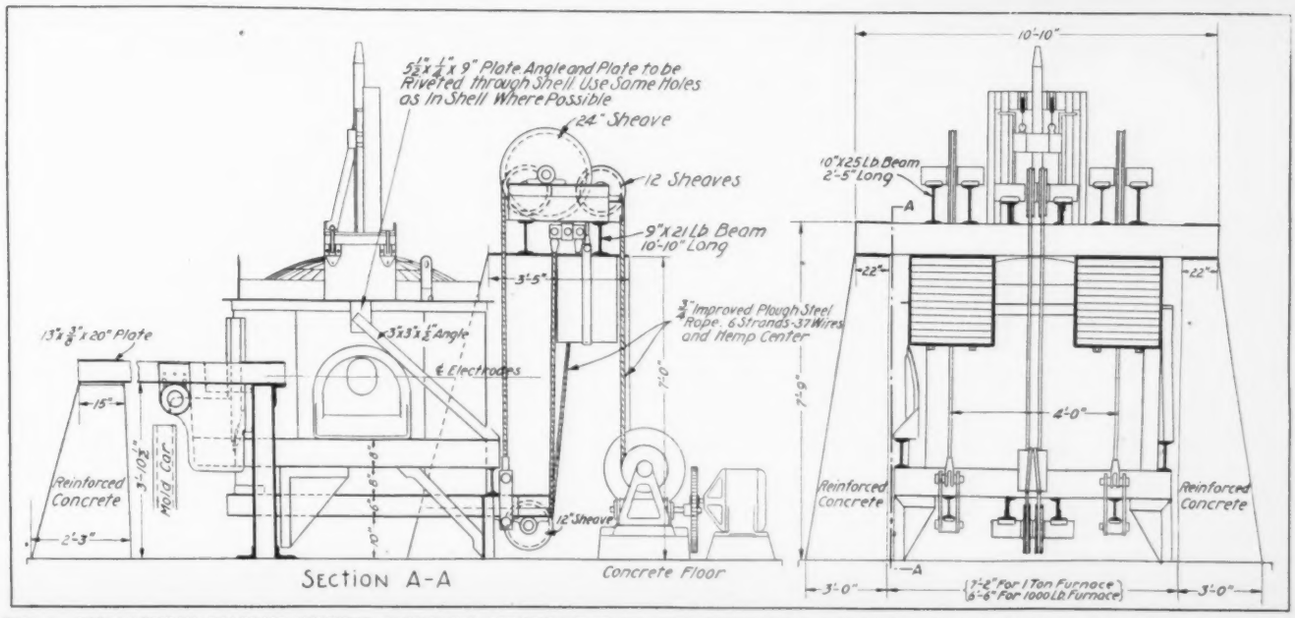


FIG. 1—CROSS-SECTION DIAGRAM SHOWING ELECTRODE ARRANGEMENT IN THE RENNERFELT FURNACE. FIG. 2—DETAILED DRAWING OF TILTING MECHANISM FOR TILTING ELECTRIC FURNACE SO THAT SPOUT IS ALWAYS AT THE SAME POINT. FIG. 3—ONE-TON RENNERFELT FURNACE INSTALLED IN UNITED STATES MINT, PHILADELPHIA

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An Unrecognized Possibility

MANY foundries employ a chemist and many more would do so if they realized what could be gained from the services of such an expert. The value of the metallurgical chemist in the foundry has not been appreciated generally and in few cases has the ability of the chemist been utilized fully. This usually has been due to the fact that the chemist seldom has been a practical foundryman and in few cases has he been given the opportunity to acquire a knowledge of the practical side of the foundry operations. As a rule the chemist has received a broad education and is capable of thinking and reasoning correctly when he understands a situation. Why does the foundry not avail itself fully of this potential power by taking in the chemist and training him in the practical side of the foundry almost as a molder's apprentice would be trained? The interest of the chemist could not be enlisted in such a project unless sufficient inducements were offered him, but such inducements could and should be offered. He should have opportunity to become assistant superintendent, or even superintendent or manager should his ability later prove him able to fill either of these positions.

What qualifications should a technical man have to start him on the road to compete for the higher positions after a year or two in practical foundry training? He should be competent to mix iron to the best advantage. To do this he should know prices thoroughly and have a knowledge of the pig iron and scrap markets. This knowledge could be gained by actually purchasing the iron, so he should be trained in this line and later be given charge of this work. His metallurgical training should enable him to melt iron in the most economical manner and bring it good and hot out of the cupola. Then why let the fact that the chemist is not familiar with handling men keep him from having entire charge of the cupolas? Rather take pains to teach him and give him experience along this line. He would also be able to take charge of pouring the iron. After the iron is in the mold it is sometimes found that there are faults in some of the castings. The foundry superintendent and the foremen, who generally are molders, are inclined to lay the trouble to the metal, but the metallurgist would be more likely to be prejudiced on the other side. As assistant superintendent he would be in a better position to enforce and test his opinions. The right kind of a man with technical training and thorough foundry experience would be a big help to any foundry and it would pay the foundry to offer inducements which would be attractive to such a man. The steel foundries and to a less extent the malleable foundries have begun to realize the possibilities of the technical man where given broader powers. The gray-iron foundries should not be far behind because their needs in this direction are just as great as are the needs of malleable and steel casting producers. Gray-iron foundries today stand in greater need of the application of science to their operations than almost any other branch of the castings industry. Technical men trained along practical and executive lines are specially fitted for this work.

Trade Outlook in the Foundry Industry

JUNE normally is considered one of the dullest months of the year in the foundry industry. New ventures which carry with them orders for castings are usually well along by midsummer and projected business for the next year generally has not reached the period of incubation at this time. This year, however, is an exception. That optimism which has been in evidence for the past two months is vindicated by the steady increase in demand for practically all classes of castings. The sales of foundry pig iron, coke and scrap, which form the most sensitive barometer of trade conditions in the foundry industry, point to a strong revival.

Covering on Iron

Foundrymen are reported as heavy buyers on pig iron both for immediate requirements and for shipment through the last quarter. Practically every large foundry center has been exceptionally active during the past two weeks, covering on requirements to the end of the year. In the Pittsburgh district the stove, radiator and sanitary goods manufacturers have purchased an aggregate of nearly 10,000 tons of iron. In the Mississippi valley stove foundries, and automobile parts plants have made every effort to cover on both pig iron and scrap requirements. In New England, eastern and Buffalo iron has found a ready sale to stove works, radiator companies and jobbing foundries while a few inquiries have been made for iron for 1920 delivery. An $8 freight rate on southern iron into the New England district has operated to prevent large sales from the Birmingham furnaces. Textile machinery manufacturers are providing a fairly large volume of business for the eastern foundries. Cast-iron pipe makers also report better conditions and municipalities are realizing that immediate needs for water extensions must be met promptly, and that lower prices are not to be expected soon. Gray-iron foundries specializing on automobile work continue to receive all the orders they can handle. Some shops near Detroit, Cleveland and Chicago are booked to capacity until the first of the year on cylinder, transmission housing and other castings alone. Manufacturers of electrical castings, such as small motor frames, transmission boxes and bases of various sorts have experienced a sudden impetus during the past few weeks. Building extensions have brought inquiries for small power units, while the domestic labor shortage carrying with it an unprecedented demand for light domestic motors for washers, fans, pumps, etc., has reacted strongly to bring business to the foundries equipped for this class of work. Jobbing shops in general state that old customers are ordering further in advance of immediate needs. The hope that present prices were due for a slump has proved groundless, and the buying public is becoming reconciled to the belief that the price level will recede slowly. This is demonstrated most strongly in the machine tool industry. Buying, which was paralyzed at the time of the armistice, slowly is recovering though many predicted that the market was saturated for a period of years. Foundries handling machine tool castings have not yet felt the revival, but an early recovery in this class of work is expected. Foreign machinery business, especially from France and Belgium, is expected now that peace is assured.

Prices of Raw Materials for Foundry Use

CORRECTED TO JUNE 24

Iron		Scrap	
No. 2 Foundry, Valley	$26.75	Heavy melting steel, Valley	$18.50 to 19.00
No. 2 Southern, Birmingham	24.75	Heavy melting steel, Pittsburgh	18.50 to 19.00
No. 2 Foundry, Chicago	26.75	Heavy melting steel, Chicago	18.00 to 18.50
No. 2 Foundry, Philadelphia	28.00 to 29.00	Stove plate, Chicago	19.00 to 19.50
Basic, Valley	25.75	No. 1 cast, Chicago	24.50 to 25.00
Malleable, Chicago	27.25	No. 1 cast, Philadelphia	22.00 to 23.00
Malleable, Buffalo	27.25	No. 1 cast, Birmingham	20.00 to 22.00
Coke		Car wheels, iron, Pittsburgh	24.00 to 25.00
Connellsville foundry coke	5.00 to 5.50	Car wheels, iron, Chicago	23.00 to 23.50
Wise county foundry coke	6.00 to 6.50	Railroad malleable, Chicago	19.50 to 20.00
		Agricultural malleable, Chicago	18.50 to 19.00

Malleable Improving

Inquiries for malleable pig iron constitute a true index of improved conditions in that branch of the castings industry. A general pick-up is noted based upon automotive requirements and also upon a steady growth of agricultural demand. The latter, however, still is somewhat reluctant and probably will not achieve its full strength until this year's crop is "made" and the money actually in hand for needed replacements of farm machinery. Malleable plants are buying iron for the remainder of the year, regardless of the slowness in agricultural lines and the absence of railway buying. Hope is generally expressed that the present session of congress will reach an early agreement on the railway question and release a large volume of orders for car castings before the summer is over. Tractor interests still are comparatively inactive, although the tendency toward expansion of existing plants and plans for numerous new tractor factories lends basis to the belief that this source will furnish an increasing demand for malleable castings in the future.

Steel Outlook Better

The past two weeks have marked the best improvement in steel foundry activities since the armistice. The heavy shops in the Pittsburgh district are busy upon steel mill requirements brought about by the expansion of rolling mills and replacements which have been delayed pending the promised revival in demand for steel products. Steel foundries through the central states are not yet on a full schedule, although the demand for truck castings, especially differential housings and wheels, miscellaneous machine parts, and some railway castings has increased operations to about 60 per cent of prewar activity.

Manufacturers of nonferrous castings report a fair demand, especially for plumbing brasses and pipe fastenings. Aluminum shops are busy upon automobile work, as many cars which had given up aluminum castings during the war have returned to their former specifications. Casting copper is quoted at 17.37 to 19.50 cents, New York. Prices on other nonferrous casting metals based on New York are: Lead, 5.40c to 5.50c; tin, Straits, future shipment, 52c to 52.50c; antimony, 8.37½c; aluminum No. 1 alloy producers' price, 31.50c. and open market, 26c. Zinc is quoted at 6.95c to 7c, St. Louis.

COMINGS AND GOINGS OF FOUNDRYMEN

CLIFFORD J. MORGAN, one of the oldest active foundrymen in Cleveland, has retired from the presidency of the Taylor & Boggis Foundry Co. For more than 40 years, Mr. Morgan was actively connected with the same company, watching its growth from a small plant employing only five men to its present extensive works which furnish employment for over 500 workmen. Mr. Morgan's retirement is coincident with the sale of the company to interests headed by I. T. Kahn, president of the Republic Structural Iron Works Co. and the Columbia Hardware Co., Cleveland. The Taylor & Boggis Foundry Co. was founded in 1865. In 1875, Mr. Morgan secured employment as bookkeeper, timekeeper, and paymaster, under the partnership mentioned. His ability and industry was recognized by a participation in the business when eight years later the company was formally incorporated by Robert H. Boggis, C. J. Morgan, F. E. Drury and C. F. Emery, following the death of Mr. Taylor, the senior partner in the old firm. Since that time the growth of the company has been steady. Mr. Morgan succeeded Robert H. Boggis as president in 1910.

William Bennett has been made foreman of the Chicago, Great Western railway foundry at Oelwein, Iowa.

J. W. Christie, formerly connected with a foundry in Grove City, Pa., has removed to Seattle, Wash.

Franklin G. Smith, president of the Cleveland-Osborn Mfg. Co., has been elected president of the Y. M. C. A. of Cleveland.

William Dryden has been promoted to foreman in charge of the Enterprise Foundry Co. plant at New Brunswick, Nova Scotia.

Edward D. Frohman, Pittsburgh manager for the S. Obermayer Co., left recently for an extended tour of the west including Yellowstone Park.

Benjamin C. Page has accepted the position of superintendent in the Sheffield plant of Fairbanks, Morse & Co., Three Rivers, Mich.

Arthur King Wood, formerly president of the Franklin Trust Co., New York, has been elected vice president and treasurer of Westinghouse, Church, Kerr & Co., New York.

John S. Banks, formerly superintendent of the Union Machine Works & Iron Foundry, Philadelphia, has been elected general manager, succeeding John McDonald, who died recently.

H. L. Wadsworth has resigned as manager for the American Foundry Equipment Co. and Sand Mixing Machine Co., Inc., combined, with headquarters at the factory in Cleveland.

R. P. Rowe has been elected president of the Belcher Malleable Iron Co., Easton, Mass., following a change in ownership and management. C. B. Swasey is treasurer of the company.

Ralph C. Velte has been appointed assistant general manager of sales with offices in the Oliver building, Pittsburgh, for the Valley Mould & Iron Corp., Sharpsville, Pa.

CLIFFORD J. MORGAN

Fred Smith, formerly with the Nevada Engineering & Supply Co., Reno, Nev., has been placed in charge of the pattern shop of the Virginia & Truckee Ry. Foundry, Carson City, Nev.

Alex T. Drysdale, who has been connected with the United States Cast Iron Pipe & Foundry Co., Birmingham, Ala., has accepted the position of superintendent for the Central Foundry Co. at Bessemer, Ala.

L. M. Moser has been made superintendent of the Advance Foundry Co., Dayton, O. Mr. Moser formerly was foundry superintendent for the Hamilton Machine Tool Co., Hamilton, O.

D. J. Kennedy recently was elected president of the Canadian Malleable Iron Co., Owen Sound, Ont. The other officers of the company are M. Kennedy Sr., vice president, and I. Guttenkunst, general manager.

J. W. Spensley who has been associated with J. N. Kinney, contracting engineer, New York, recently was appointed eastern sales engineer for the Champion Engineering Co., Kenton, O., electric crane manufacturer.

George Charlton, who has been connected with the Atlas Crucible Steel Co., Dunkirk, N. Y., for the past 18 months, is doing special metallurgical work for that company in connection with the study of heat-treating tool steels.

H. L. Garbutt, for the past six years manager of the line material section of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been made manager of the supply division of the company's San Francisco office.

John C. Theise, who was formerly assistant superintendent with McIntosh & Seymour Corp., Auburn, N. Y., has been placed in charge of the brass foundry at the Harrison, N. J., works of the Worthington Pump & Machinery Corp.

John A. Guy is now superintendent of the steel plant of the American Radiator Co., Buffalo. Previously he was connected with the Ludlum Steel Co., Watervliet, N. Y., where he had charge of the iron and steel foundry for that company.

J. Harvey Giles who became connected with the Barber Asphalt Co., Chicago, in 1915, has resigned to return to the Drummond Mfg. Co., Louisville, Ky., as general manager. Mr. Giles was previously with the Drummond company for a period of 14 years.

Albert L. Brown, who has been made general foundry foreman for the Star Drilling Machine Co., Akron, O., was formerly with the Commonwealth Steel Co., Granite City, Ill., the Duquesne Steel Foundry Co., Pittsburgh, and more recently the Kansas City Hay Press Co., Kansas City, Mo.

H. E. Copeland, who for the past five years was chemist and metallurgical engineer for the Lenoir Car Works, Lenoir City, Tenn., has accepted a position as chemical engineer with the Hill & Griffith Co., Cincinnati, where he is installing a laboratory to develop foundry compounds and facings.

C. F. Michael has been elected president of the reorganized Carroll Foundry & Machine Co., Bucyrus, O. The

other officers of the company are A. G. Stoltz, secretary; W. H. Picking, treasurer, and Fred C. Horn, formerly with the Ohio Foundry Co., assistant secretary-treasurer.

J. W. McCabe who until recently was Buffalo district manager for the Chicago Pneumatic Tool Co., Chicago, has been appointed special representative for the company's foreign trade department and will leave soon for an extended trip through the Orient, Australia and the Philippine Islands.

Bert Reeves, formerly foreman for the American Machine & Mfg. Co., Atlanta, Ga., and for the past two years connected with the National Steel Casting Co., Montpelier, Ind., has been made superintendent of the steel department of the Lucy Mfg. Corp. of Texas, Houston, Tex., manufacturer of oilfield machinery and equipment. Mr. Reeves' foundry experience covers the past 20 years.

Harry L. Kaplan, Cleveland, will take passage on July 5 to return to Palestine to take charge of his foundry and iron works which was captured by the Turks early in the war and later reclaimed and operated by the British. Mr. Kaplan expects to make some necessary improvements to his plant, and build up an organization to handle American machinery and materials in Palestine, Egypt, Turkey and Syria. He desires information and prices on foundry supplies, light power machinery, tools, coke and pig iron for export to the countries named. Mr. Kaplan's address until early November will be in care of the American-Palestine Iron Works, Jaffa, Palestine.

Joseph L. Gard

Joseph L. Gard, whose death was reported in the June 15 issue of THE FOUNDRY, represented a high type of practical skill combined with theoretical knowledge. His experience, extending over 40 years, endowed him with those traits of initiative which have made the American pattern-

JOSEPH L. GARD

maker supreme in resourcefulness. Mr. Gard was born in New Albany, Ind., in 1865. His boyhood tendencies, manifested through constructing toys and objects in wood, led to his apprenticeship in a carpenter shop when he was only 15 years old. In 1880 he became a patternmaker's apprentice with Joseph Myrick, Louisville, Ky. From this time forward, he worked at the trade in Louisville and later in shops in Chicago and vicinity until 1887 when he removed to Denver. In 1889 Mr. Gard started his own shop. He developed his equipment with a view to doing every possible operation with machinery. He invented and perfected a number of special machine tools of his own design, and these, with the standard machines which he installed, made his shop one of the most completely equipped in the west. Mr. Gard's writings on the subject of patternmaking usually took the line of practical suggestions which were presented in a simple and direct manner. His death prevented his writing a book on the subject of patternmaking, which was to have engaged his attention this year.

Merge Rockford Plants

George D. Roper, principal owner of the Eclipse Gas Stove Co., the Trahern Pump Co., the American Foundry Co. and the Rockford Enamel Mfg. Co., all of Rockford, Ill., has merged them in a new concern to be known as the George D. Roper Co. The new concern also will include the Leader Iron Works of Decatur, Ill., which has been purchased and affiliated with the Trahern Pump Co. of Rockford. Capitalization of the George D. Roper Co. will probably be about $1,500,000. Officers are expected to be those of the Eclipse Gas Stove Co., George D. Roper, president; Mahon P. Roper, vice president and treasurer; Watson E. Derwent, secretary, and H. J. Jilbert, general superintendent.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

A foundry, 112 x 152 feet, is being erected by the Quincy Casting Co., Cedar Rapids, Iowa.

C. L. Probst and others of Lynchburg, Va., are reported planning the erection of a foundry.

The Robbins & Meyers Co., Springfield, O., is reported planning to erect a plant in Canada.

The Grand Detour Plow Co. has merged with the J. I. Case Threshing Machine Co., Racine, Wis.

Fire recently damaged the plant of the Buhl Malleable Co., Wight and Adair streets, Detroit.

The foundry at the plant of the Onondaga Steel Co., Syracuse, N. Y., recently was damaged by fire.

Permission to erect an addition to its plant has been granted the Estate Stove Co., Hamilton, O., by the city building commissioner.

Henry T. White head of the L. Brayton Foundry Co., Riverpoint, R. I., has plans for a 6-machine unit plant to be built at Pastime Park.

Directors of the Hydraulic Press Mfg. Co., Mt. Gilead, O., have authorized General Manager McMillan to install a foundry in connection with the plant.

Permits for the erection of plant additions have been taken out by the Ohio Steel Foundry Co., Springfield, O.

The Pittsburgh Malleable Iron Co., Thirty-fourth and Smallman streets, Pittsburgh, recently acquired the 2-story building of the Keystone Axle Works.

The capacity of the Indiana Foundry Co., Indiana, Pa., is being doubled. Construction of a new cleaning room, 70 x 140 feet, recently was completed.

An increase in capital from $65,000 to $150,000 has been effected by the Mahoning Foundry Co., 618 Poland avenue, Youngstown, O.

A report is current to the effect the Homer Foundry Co., Homer, Mich., is planning to move its plant to Coldwater, Minn.

A contract has been let to Stanley W. Stader for the erection of an addition to the plant of the Sterling Aluminum Co., 2216 Cherry street, Erie, Pa.

A recent increase in capital from $300,000 to $600,000 was made by the Eclipse Stove Co., Mansfield, O.

The Decatur Brass Works, Decatur, Ill., has purchased a factory building and is remodeling it and building a new foundry.

The American Aluminum Ware Co., 374 Jelliffe avenue, Newark, N. J., it is reported, is planning to erect a plant, 39 x 50 feet.

A modern pattern shop, one story, 40 x 70 feet, will be erected by the R. Hitchcock Modern Pattern Co., 3241 Thirtieth avenue, Minneapolis.

Plans for the erection of a foundry, 120 x 400 feet, are being prepared for the Moline Plow Co., Moline, Ill.

Ground will be broken shortly for the erection of a new plant for the Arneson Foundry Co., Kenosha,

Wis., manufacturer of brass and heavy iron castings.

A contract has been placed by the Superior Foundry Co., Cleveland, for the erection of an addition, 60 x 131 feet.

An addition to the plant of the Belding Foundry Co., Belding, Mich., is under construction. When completed it will be 75 x 130 feet.

John J. Ward, 1 Deerfield terrace, Providence, R. I., and others recently organized the Continental Bronze Co., 48 Oxford street, Providence, R. I.

Extensive improvements are to be made at the plant of the Sterling Steel Foundry Co., Braddock, Pa., according to a current report.

The Frazer & Jones Co., Syracuse, N. Y., is reported planning the erection of an addition to its foundry.

C. A. Goldsmith, 270 Thomas street, Newark, N. J., has had plans prepared for the erection of a modern pattern shop.

The Bowman Realty & Bonding Co., National Bank building, St. Louis, is reported having plans prepared for a foundry, shop, office and store buildings.

Contracts have been let by the Davis Foundry Co., Lawrence, Mass., for the erection of a foundry, 100 x 200 feet.

A contract has been awarded by the Novo Engine Co., Lansing, Mich., for the erection of a foundry, 90 x 100 feet and 100 x 160 feet.

The Lycoming Foundry & Machine Co., Williamsport, Pa., has increased its capital from $150,000 to $1,000,000.

The Niagara Brass Mfg. Co., 165 Adams street, Buffalo, has purchased the Holly Co. shops at Lockport, N. Y., and will use them as a brass foundry and machine shop.

Among the recent incorporations is that of the Thacher Propeller & Foundry Corp., Albany, N. Y The company is capitalized at $1,200,000 and was incorporated by H. S. Bell, T. C. and G. H. Thacher.

Incorporated under the laws of Delaware, the H. & H. Foundry Co., capitalized at $1,000,000, has taken over the plant of the John Davenport Co., Stamford, Conn.

Hunt, Helm, Ferris & Co., Harvard, Ill., have had plans drawn for the erection of a gray iron foundry. Construction of the building is expected to be started soon.

Organized in Detroit to manufacture gray iron castings, the Mills-Botts-Adams Foundry Co., has opened temporary offices at 310 New Telegraph building, Detroit.

A portion of the plant of the Toledo Stove & Range Co., Toledo, O., has been taken over by the Toledo Scale Co. An addition to the building is being erected.

Purchase of a plant site by the Crucible Steel Castings Co., Champlain avenue and Canal street, Cleveland, recently was announced. The company plans to erect a modern plant on the site.

The Frank L. Wells Co., Kenosha, Wis., has started work on the erection of additions to its foundry and machine shop, 75 x 150 feet. Frank L. Wells is general manager.

Directors of the Taylor & Fenn Co., 54 Arch street, Hartford, Conn., founders and machinists, have authorized an increase in capital, from $250,000 to $500,000.

The Billings & Spencer Co., Park and Laurel streets, Hartford, Conn., will build an addition to its plant, which will include a foundry, 60 x 80 feet.

Plans are being prepared for the erection of a plant addition, 32 x 100 feet, for the Victor Aluminum Mfg. Co., Wellsville, N. Y., of which J. L. Rockwell, Hornell, N. Y., is president.

Plans have been prepared for the erection of an addition to the foundry of James Spence, 911 Garfield avenue, Jersey City, N. J. The extension will be 44 x 60 feet.

Construction of a plant is contemplated by the Windsor Foundry Corp., Windsor, Vt., which recently was organized. The building will be 80 x 200 feet. Temporary operations are being carried on at the plant of the Cooley-Wright Mfg. Co.

A recent Ohio incorporation is that of the Machine Steel Casting Co., Alliance, O. The company, which is capitalized at $1,000,000, was incorporated by W. E. Trump, H. Y. Stuckey, F. R. Donaldson, J. B. Freer and others.

Erection of a foundry addition, 100 x 142 feet, recntly was completed at the plant of the Iowa Malleable Iron Co., Fairfield, Iowa. W. V. Hughes, secretary, states the company has purchased all the necessary equipment.

Plans are being drawn for the erection of a brass works and foundry, 55 x 120 feet and 50 x 50 feet, for the Peninsular Brass Works, York and Cass avenues, Detroit. A. W. Fussey is general manager of the company.

The Detroit Stove Works, 1320 Jefferson avenue, Detroit, has increased its daily capacity to 250 gas ranges, 150 coal and wood stoves and 30 furnaces. The company also produces 800 car heaters and from 500 to 1000 electric stoves a year.

A recent incorporation is that of John F. Birch, Inc., machine shop and foundry supplies. The company is capitalized at $10,000 and was incorporated by F. Warner, L. M. and J. F. Birch, 300 East 103rd street, New York.

A contract has been awarded by the Nickel Plate Foundry Co., East Cleveland, O., for the erection of a foundry, 74 x 160 feet. The details are in charge of R. P. Chamberlain, 948 Engineers building, Cleveland.

Fire on the night of June 18 destroyed the reclamation plant and equipment of the Victoria Metal Co., Erie, Pa., founders of brass, bronze, aluminum and white metal castings. Plans are now being prepared for the reconstruction of the plant and equipment will be purchased shortly.

Work on a $1,000,000 steel casting plant is expected to be started shortly, according to information said to have been given out by W. H. Purcell, head of a new foundry corporation, which will locate at Alliance, O. The city has pledged a site to the company.

The Albany Foundry Sands, Inc., Albany, N. Y., recently was incorporated with $8000 capital, to produce and distribute molding sands, etc. Incorporators of the company are Walter B. Jewett, H. A. Schaupp and Edward A. Bond. The company's office is at 100 State street, Albany, N. Y.

Work is to start at once on the erection of a gray iron foundry with a 20-ton daily capacity, for the Defiance Machine Works, Defiance, O. This foundry will produce machine tool castings. Clement A. Hardy, Railway Exchange building, Chicago, is engineer in charge of construction.

H. C. Dahl, 231 South Eighth street, Philadelphia, has the general contract to erect a foundry, 90 x 180 feet, for the Roberts & Mander Stove Co., 1631 North Fifth street, Philadelphia, of which C. V. Roberts is president. The plant will be built at Harboro, Pa.

The Troy Foundry & Machine Co., Inc., Boston, has been incorporated with $1,500,000 capital to make iron products, by Thomas C. Perkins, Hartford, Conn., Allan M. McCaffray, Newton, Mass., S. Bradstreet, Boston, John S. Ferris, Newton, Mass., and Alton Z. Tupper, Arlington, Mass.

A machine shop, 110 x 400 feet, and a boiler shop, 30 x 44 feet, is being erected by the Iron Mountain Co., 6416 Stony Island avenue, Chicago, which was recently incorporated to build engines. Architects are now drawing plans for the erection of a gray iron foundry. Carl H. Peterson is president of the company.

The Eagle Stove Works, recently organized at Rome, Ga., rapidly is getting into shape for the manufacture of stoves. The company has purchased the property of the Rome Scale & Mfg. Co., and besides utilizing these buildings, is erecting a new building, 100 x 175 feet, which will be used as a foundry. B. W. Green is manager of the company.

The Bass Foundry & Machine Co., Ft. Wayne, Ind., owners of the Rock Run charcoal furnace in Cherokee county, Ala., recntly announced that an office would be opened in Birmingham, Ala. The furnace is to be improved and enlarged and a large foundry and machine shop erected. At this plant, machinery, axles, car wheels, engines and power plant equipment will be manufactured.

Plans have been drawn by the Austin Co., Cleveland, for the erection of a machine shop, pattern shop and foundry, for the Cleveland Rubber Mold Foundry & Machine Co., 406 Schofield building, Cleveland. The company has purchased a 10-acre site on Warner road, and erection of the building, which will be 120 x 240 feet, will be started shortly. I. R. Davies is president of the company.

Holcroft & Co., Detroit, have the following jobs under construction: Three batteries of core ovens for the D. J. Ryan Foundry Co., Ecorse, Detroit; two batteries of core ovens for the Whitehead & Kales Iron Works, Detroit; a battery of ovens at the plant of the Kelsey Wheel Co., Detroit; a battery of five ovens at the Novo Engine Co., Lansing, Mich.; a battery of six core ovens for the Hamilton Foundry & Machine Co., Hamilton, O.; two batteries of core ovens for the Saginaw Malleable Iron Co., Saginaw, Mich.; a battery of four ovens for the Nash Motors Co., Kenosha, Wis., and two batteries of four ovens each for the Maxwell Motor Co., Dayton, O.

New Trade Publications

LIFT-TRUCKS.—A cardboard folder has been prepared by the Stuebing Truck Co., Cincinnati, in which lift-trucks manufactured by the company are described. These trucks, it is said, are built of steel, have few parts, are of standardized construction, are equipped with roller bearings, have a positive hydraulic check and are built in such a way that there is little time lost in loading or unloading.

SAW BENCHES.—A 4-page folder is being distributed by the Oliver Machinery Co., Grand Rapids, Mich., in which a saw bench is described and illustrated. Incorporated in the specifications of this bench are two saw arbors for rip and cross-cut saws, roller bearing table and a self-locking tilting mechanism. A feature is the safety appliances, etc., which go with the bench.

LUMBER.—A treatise on America's second largest industry, that of lumbering, is given in an illustrated booklet recently issued by the General Lumber Co., Milwaukee. The booklet is illustrated with numerous half-tone cuts showing the various processes of lumber manufacture, activities of the "lumberjacks" and scenes at logging camps. The treatise is concise, and gives the reader a brief outline of the various steps of logging and lumber sawing.

CRANES.—A condensed general catalog in which electric traveling cranes, hand power cranes, bridge and gantry cranes, pillar and jib cranes, monorail hoists, etc., are described and illustrated, recently was published by the Northern Engineering Works, Detroit. Most of the booklet is devoted to illustrations showing the various parts of the cranes and actual installations. One section of the booklet is devoted to a description of crane trolleys.

OIL FURNACE.—A 4-page bulletin has been issued by the Ingersoll-Rand Co., New York, in which an oil furnace for use in mines and shops for the heating of drill steel, is described and illustrated. The main frame of the furnace is of gray iron mounted on a pedestal of the same material. The hood is in one piece and the drill rest can be easily adjusted for the various lengths of steel. The furnace is equipped with a plate for the protection of the operator which shuts off the glare and reflects back the heat. This plate is carried by two adjustable steel rods. The burner is the low pressure type and will operate on air supplied from a low pressure or high pressure source.

AIR COMPRESSORS.—Single-stage, vertical air compressors for belt drive are described and illustrated in a 12-page booklet recently published by the Ingersoll-Rand Co., New York. According to the booklet, compressors of this type place at the command of the small shop a source of air power that enables it to do away with slower methods. These compressors are of the vertical, single-stage, single-acting, self-oiling, enclosed, center crank type. The unit consists of a main frame, enclosing the main bearings, crankshaft and connecting rod, and providing a basin for the lubrication system. The air cylinder is on the top of the main frame. These compressors are built in four sizes. The standard design includes a single belt wheel.